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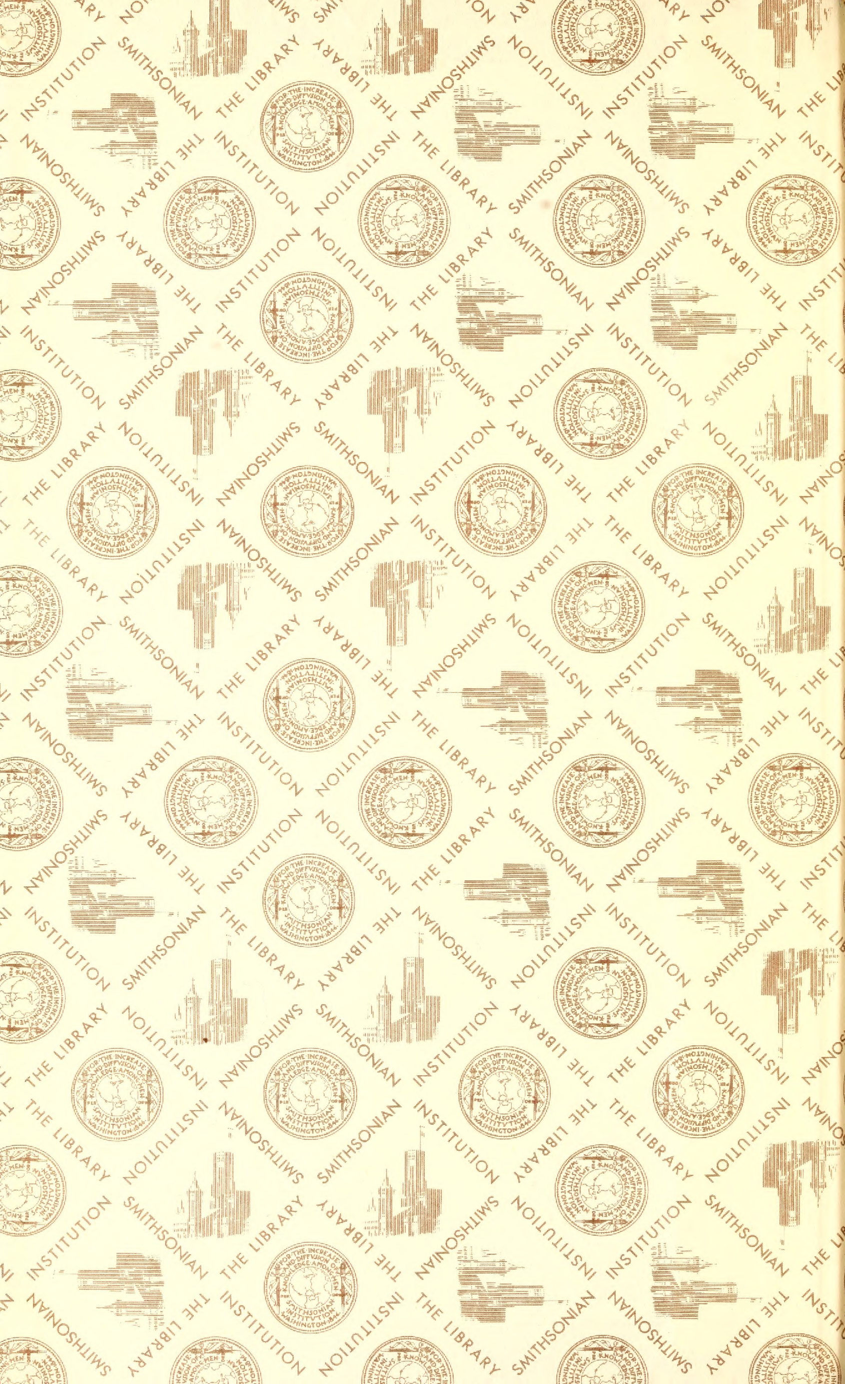
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In Vol. **62** at p. 139 in the third line of the heading of Review No. 7 : for ‘ 1946 ’ read ‘ 1964 ’.

JOURNAL
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HISTORY SOCIETY

1965 APRIL Vol. 62 No. 1

The Yellow-wattled Lapwing, *Vanellus malabaricus* (Boddaert), a tropical dry-season nester

II. Additional data on breeding biology

BY

S. D. Jayakar and H. Spurway
Genetics and Biometry Laboratory, Government of Orissa, Bhubaneswar

(*With a plate*)

INTRODUCTION

We have recently published (Jayakar & Spurway 1965) an account of the incubation behaviour of *Vanellus malabaricus* in the large exposed gardens of a residential area of New Capital, Bhubaneswar. This paper continues these observations, and provides provisional answers to some of the questions raised.

The terrain consists of lateritic rock with a thin top-soil recently cleared in order to be covered with relatively large thinly-spaced buildings. These building operations ensure that, in addition to the outdoor taps, which are a feature of India, there are also many temporary sources of water. The average monthly rainfalls in millimetres beginning with January are : 14·5, 23·6, 16·0, 23·4, 67·3, 216·7, 336·8, 320·0, 248·8, 158·0, 53·3, and 4·8.

The observations were primarily made from our house, which is shaded in the present map (see Plate) and shown in part in the map in our previous paper. The map shows an area of about 15 hectares or 37 acres which can be critically surveyed from the roof of this house.

Within this area tarred roads are shown hatched. These are bordered by pavements and/or grass verges. Other roads and lanes are shown by parallel lines. To the north and north-east uneven treeless wasteland extends for over 350 m. In all other directions visibility is abruptly obscured by buildings (not all of which are marked) and their associated hedges and trees. Nests were of course regularly visited, and were also watched from various verandahs of the same house. This area was surveyed on most days from 21/xii/63 usually for over an hour in the evening while a roosting census was being taken.

We have previously discussed the idiosyncracies of wattle and wing coloration by which we distinguish the members of a pair. Similar characters were appreciated in pair 6 but not pairs 5 and 7. The male of pair 6 (again defined as the animal who invariably trod during copulation) walked awkwardly and flew with his right leg dangling.

Once again we thank our neighbour Shri S. K. Ghose for allowing us to watch nest 3′ and the tap, both of which were in his garden.

BREEDING ECONOMY

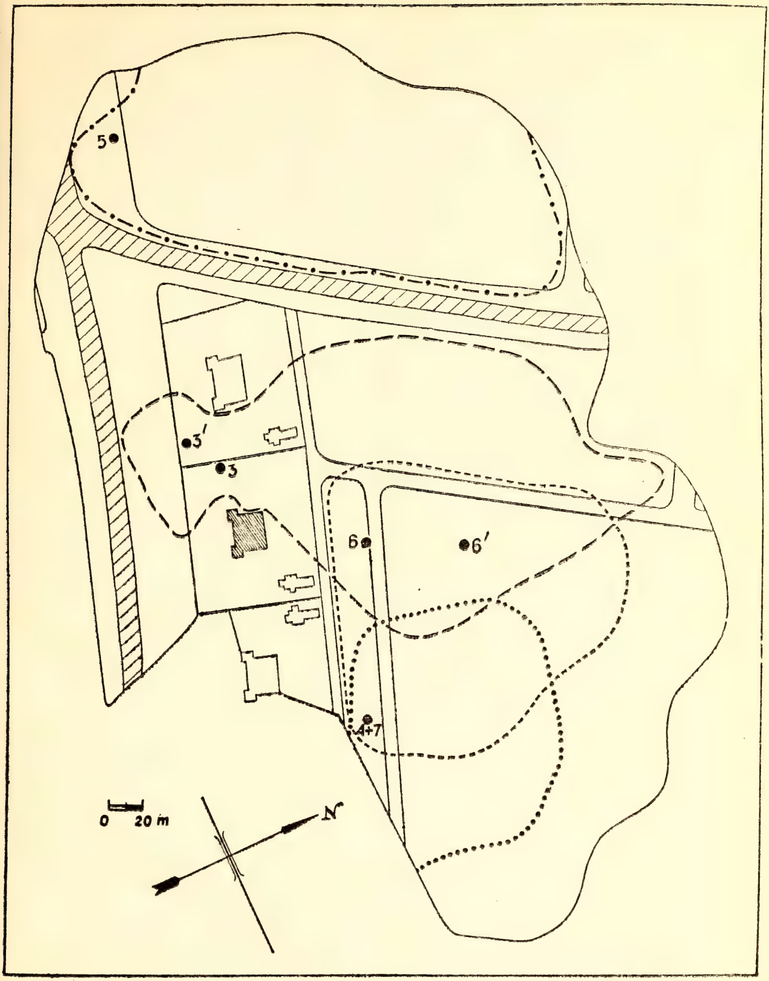
Table I lists some figures for the 7 clutches found during 1964 ; and the location of these and the associated territories are mapped in the Plate.

TABLE I

DATES OF OBSERVATIONS MADE

Clutch	3	4	3′	5	6	7 (perhaps 4″)	6′
0 egg	..	..	..	..	**19/iv**	..	**15/v**
1 egg	..	..	..	..	21/iv	..	21/v
2 eggs					22/iv		22/v
3 eggs			**12/iv**		24/iv		24/v
4 eggs	**8/ii**	**12/ii**	13/iv	**19/iv**	25/iv	13/v	25/v
1 egg missing	15/ii						11/vi
4 eggs missing		19/ii			13/v		
1 chick (3 or 2 eggs)	3/iii[1]		9/v	21/iv			19/vi
2 chicks (2 or 1 eggs)			10/v				20/vi
3 chicks (1 or 0 egg)			10/v			4/vi	
1 chick 0 egg				22/iv			22/vi
empty	8/iii[2]		11/v[2]	23/iv		5/vi	22/vi
No. of eggs hatched	1	0	3	4	0	4	3
1st chick flying	4/iv		14/vi	[2/vi ?]		..	21/vii
chicks last seen	27/iv		24/vi	[2/vi ?]	..	2/vii	22/vii
No. flying	1	..	2	[1 ?]	..	0	1
parents last seen	..		29/vi	[2/vi ?]	..	7/vii	22/vii

NOTE : Bold face indicates date nest found.
[1]—helped out of shell (see Jayakar & Spurway 1965).
[2]—unhatched eggs collected.



Area kept under observation from the roof of our house.

The house is closely hatched in the figure. Widely hatched portions indicate tarred roads. Other pairs of parallel lines indicate untarred roads or public areas bordering roads. Nests are indicated by numbered dots. Approximate maximum boundaries of territories shown by

broken lines as follows : — — — — — pair 3 ; - - - - - - - - - - - pair 6 ;

• • • • • • • • • • • • pair 7 ; •—•—•—•—• pair 5.

Pairs 3 and 6 laid two clutches each: 3 and 3′, and 6 and 6′ respectively. On 6/iii, pair 3 led their only hatchling of clutch 3 away from the nest leaving 2 unhatched eggs. On 4/iv, they were first recorded nest-building and copulating in the region where they laid clutch 3′, and one or both of them were seen in this area on several days between then and the finding of the nest. We can presume that the first egg of clutch 3′ was laid on 9/iv or 10/iv. Therefore this pair, who were rearing a first brood, selected a new nest site about 29 days after they had deserted their first nest, and laid the first egg of their second clutch 5 to 6 days later. Pair 6 lost their first clutch completely on 13/v, and within 2 days, on 15/v, they were nest-building on their new site, and they also laid the first egg of their second clutch 6 days after site selection.

All seven clutches contained 4 eggs. Pair 3 were incubating before the fourth egg of clutch 3′ was laid; and pair 6 incubated their first clutch from the laying of the first egg. Indeed they often sat on the nest on 20/iv while nest-building by flicking pebbles. They were not watched during the hotter and therefore critical hours while clutch 6′ was still incomplete. Both clutches we observed through their laying (clutches 6 and 6′) took 5 days to lay, the last egg being 4 days younger than the first, and it seems a rule that birds, unlike reptiles, lay not more than one egg a day. On both occasions where all four eggs hatched (clutches 5 and 7) the whole clutch hatched in approximately 24 hours. In nest 1 in 1963, where the process was watched in detail, the fourth egg-shell was removed from the nest 23 hours 10 min. after the first. The timing of the *three* hatches of nest 6′ seems abnormally long, but even so it is one day shorter than the laying period of the full clutch of four. Therefore some regulation seems to occur causing the eggs to hatch approximately simultaneously so intra-litter selection need not be invariably biased in favour of the first hatched. Considering the early afternoon temperatures to which the nests of *V. malabaricus* are exposed, it is not surprising that incubation is not delayed until the clutch is complete. Such delay is the device used by birds nesting in cooler microclimates to obtain synchronisation of hatching. One is reminded of the observation that the litters of ‘ live-bearing ’ fish (Poeciliidae) consist of fry which are all born at the same developmental stage though the individual embryonic lives range from 3 to 4 weeks (Turner 1937).

We have no undepleted clutch from which to calculate the incubation period defined as the interval between the first oviposition and the first hatch. Using this measure on depleted clutch 6′ we obtain 29 days. Considering the *last* oviposition to the *last* hatch we obtain 27 and 28 days from the depleted clutches 3′ and 6′ respectively. If we are correct that nest 7 was not established on 8/v, the first egg could not have been laid earlier than 9/v, and therefore the incubation period was as short as 26 days.

Considering these figures we can discuss the fact that clutch 7 was laid in the same scrape as nest 4. Unfortunately we did not learn to recognize pair 4 morphologically. Wynne-Edwards (1962, pp. 156 and 408) gives references to the re-use of a scrape during a series of seasons by different individuals of the same species, or by different species, and we do not yet know for this species how complete the re-apportioning of territories can be within one breeding season. A territory containing this scrape would be expected to extend into gardens which are invisible from our roof, as the territory of pair 7 was later seen to do. Therefore it is possible that pair 4 built a nest in one of these between 19/ii and 13/v, meanwhile relaxing its hold on the north-western part of its territory which was temporarily taken over by pair 6. Certainly birds were repeatedly seen in this area screaming at inter-specific intruders and displaying at the other conspecific pairs. However pair 6 and 7, who both finally held territories to the east of that of pair 3, were not recognized morphologically until they were associated with their respective nest sites. Using the times obtained from the other nests it is chronologically possible for pair 4 to have built a nest (4′) where it could not be seen by us, from which the young were reared, and that nest 7 represents nest 4″. There were no flying young birds seen accompanying pair 7 in the manner that the survivor of their first clutch accompanied pair 3 for more than half the incubation period of their second clutch (see next section). However, it is possible that the young may sometimes leave their parents as soon as they can fly, or the hypothesised brood 4′ may have been lost late in childhood.

The hatching success for 1964 is 15 out of 28, and if we add our two 1963 nests in which all the eight eggs hatched 23 out of 36, i.e. so far, it lies between 54 and 64%. In these estimates we make one logically dubious assumption which is probably biologically correct. The earlier hatchlings certainly step off the nest before all the eggs are hatched. Therefore, if an egg disappears before hatching has begun, we consider that egg lost (we have seen one taken by a crow, *Corvus macrorhynchos*), but if an egg disappears after hatching has begun, we assume a successful hatch, the shell having been removed and the chick having left the nest. Though our only unhatched eggs occurred in nests we were watching, we do not think this is because we minimised predation of the nest.

We are only certain that 4 of our hatchlings survived to fly, on two occasions 32 days after it, or its eldest sibling, hatched. It is probable that one chick of family 5 also survived, but this family was only recognized by its territory which was far away. Also, it is just possible that family 7 moved to a region of their territory not visible from our roof before any of clutch 7 were able to fly. That only 5 young from 28 eggs, laid by 8 or 10 parents, survived even infancy may not be disastrous in the light of the mortality rates discovered in *V. vanellus* (Lack 1954 ; Haldane 1955).

The Plate shows, outlined with various broken lines, the areas on which a given pair was seen feeding at any time during the season. We consider that these feeding areas coincide with the territories. Firstly, at any given instant they were mutually exclusive but contiguous, there being no neutral ground between them. Had there been a neutral ground between territories, at no place would more than one pair display, which was certainly commonly seen. No adult intruder, if noticed, was ever allowed to forage, but was greeted with agonistic behaviour, which was often followed by copulation by the pair in possession. These displays against intruders occurred not only at the boundaries between two territories but well within them. During our continuous watching in February we saw in detail many examples of the latter. If these were attempts by newcomers to appropriate some of the territory held by pair 3 in our garden they were unsuccessful. However pair 6 did move in on some of the territory previously held by 3 in the wasteland. The territory of 3 was at its largest early in the season, the pair staking a claim exceptionally early according to all previous authors. However this territory did not constantly contract but its boundaries fluctuated, perhaps even from day to day, according to whether pair 3 or pair 6 were occupied, for example with incubation, in a region remote from the disputed area. From the map, pair 7 appears to have similarly invaded part of the territory of pair 6. However as clutches 4 and 7 were laid in the same scrape, they may well have been laid by the same parents (see above). On this interpretation the relevant area was first held by pair 4 who relaxed their hold for a while and subsequently re-established it.

Secondly, the nests were also in these feeding territories. Nest 3′ was certainly in the area held while nest 3 was being incubated, and nest 6′ probably in the area associated with nest 6.

Finally, no chick too young to fly was ever seen feeding outside the territory held by its parents, and this was exceptional even after they did fly.

The maximum areas of territories 3 and 6 as shown in the map were 3.47 hectares (8.75 acres) and 2.59 hectares (6.40 acres) respectively. These are much larger than those of the European lapwing *V. vanellus* which range from 0.5 to around 2 acres. This is correlated with the different economy of *V. vanellus* where both the adults and the chicks feed outside their territories. These are only exceptionally adjoining, and at a period when *V. vanellus* was considered a common species, several frequencies ranging from 2 to 3 pairs to 18 pairs per 1000 acres were found on different habitats (Nicholson 1951, p. 77, and Wynne-Edwards 1962 for summaries), compared with the 5 (or 4) pairs of *V. malabaricus* we observed in an area of about 40 acres.

MEMBER OF A FIRST BROOD ACCOMPANYING ITS PARENTS DURING INCUBATION OF A SECOND BROOD

After leaving nest 3, and before we found their second clutch (nest 3′), the parents were regularly seen with their chick in their territory during the 1½ or 2 hours before dusk while S.D.J. was making another set of observations from the roof. They were seen on all days when they were looked for, except two, and were seen to copulate three times. It is possible that they had a daily routine of movements within their territory, since on 9 days we saw them in our garden, or the garden to the west, at dusk, having just arrived there from the wasteland to the north. The solitary chick was always seen in the company of its parents until 7/iv, 3 days after it was first seen to fly, and even after that, it could frequently be found with one or other of them. This remained true on and after 12/iv when we discovered nest 3′ with three eggs already present. The chick was seen often enough during the inspections of nest 3′ for us to presume that it still spent a large part of its time in the company of its parents, and this was confirmed during our periods of continuous observation begun on 26/iv. During these periods on 26/iv and 27/iv, the chick groomed and fed in regions of shade near the new nest including the so-called tap-region which had so much valence for the incubating birds (see next section).

At this time the young bird was only a little smaller than an adult, and the black of its head and the yellow of its legs and wattles were paler. The wattles were not fully grown and did not overlap over the beak and forehead. The back was brindled instead of a uniform fawn.

When watching was continuous, it was observed that both parents pecked, lunged, flew, or ran a few steps at the chick, causing it to retreat. The chick also avoided walking too near to its parents, making detours to avoid passing within 40-50 cm. of either of them. Finally at 14.56 on 27/iv the father flew over the chick causing it also to fly. After both had landed the father performed, for a second or so, the display which a pair use, often together, at a conspecific intruder in their territory. This is derived from a ground pecking movement and quite characteristic and conspicuous, being highly ritualized. The father then ran a few steps after the chick. They paused 1.25 m. apart ; then the chick walked east into the next (the observers') garden and spent about an hour eating, grooming, sitting, and stretching. After flying away, it did not return to its family or to their territory at least until it had further developed so as to have become unrecognizable. This breaking of filial ties, like several other crises in the lives of this species (Jayakar & Spurway 1965, and next section) coincided with a severe storm from 19.30-20.30 the same evening (27/iv). It is not known whether this storm played any part in disrupting the family, nor whether the ritualized display was more potent than the several pecks in driving off the young bird, who had spent over 17 days in the company of its parents after they had started incubating a second clutch.

As the whole of the first clutch of pair 6 was lost, there were no half-grown birds to accompany their parents during the incubation of clutch 6′. Lack (1954, p. 95) considers that pairs of *V. vanellus* never rear more than one brood a year.

EGG-WETTING BY PAIR 3

Owing to details of cultivation, we were unable to find in either garden, a viewing point acceptable to the birds, from which we could see enough to justify continuous watching of the second nest (3′) of pair 3. However as this nest was located in the same general region as nest 1 in 1963 and incubated even later in the season, it provided an opportunity to see whether birds who had not wetted their eggs during February and March would do so during April and May. Therefore, beginning just after noon on 26/iv, the tap at which pair 1 had wetted themselves before going to the nest was watched during the hottest hours of the day from the same verandah as had been used previously to watch the earlier nesting behaviour of pair 3 (Jayakar & Spurway 1965).

This tap, which is 23 metres from the south hedge of the garden immediately to the west of ours and 5.5 metres west of the hedge between them, is carried on a vertical concrete post on the west edge of a concrete pavement 1.25 m. square surrounded by a rim about 10 cm. high. The pavement slopes towards a drain in the east side near its south-east corner. As the tap dripped continuously, this drain stimulated a dense growth of small herbs just east of the rim obstructing observation of that region of the pavement in which there was always standing water.

Among these herbs grows a banana. The *Duranta* sp. hedge to the east of the tap is fortunately thin in this region, but nevertheless, during the period of observation, there was little unshaded ground between it and the banana. The region of the above-listed objects will be called the tap-region. During the periods of observation, the birds seldom left this tap-region during their off-duty periods, as we have called the period between stepping *off* and stepping *onto* the nest, and which we will discuss in detail elsewhere. The birds seldom walked through any of the regions of shade of eddies which had been their favourites while off duty from their earlier nest, and never behaved as though these had any valence for them.

Except on 26/iv, watching was always begun before 11.00 and except on 10/v and 11/v continued until 16.30. On 10/v watching was discontinued at 16.01 because the light was too poor to see the birds both of whom were rushing about and screaming. A violent dust storm began at 16.06 followed by heavy rain at 16.08. This storm may have precipitated the desertion of the nest, and certainly introduced a doubt as to when this occurred. After the female left the tap pavement at 15.19, and the male left the nest at 15.46, neither bird was seen either to enter the tap-region or incubate again, though both parents not only flew but ran about screaming when three chicks and a sterile egg were observed in the nest at 17.10. On 11/v, as the family had not visited either the nest or the tap pavement that day, and as the chicks had walked out of the observers' field of vision before 13.49, watching was discontinued at 15.05. As 11/v was thus outside the incubation period the hours of watching are not included in Table IV.

The nest itself was obscured by the hedge, and during the middle of the day, the high sun flattered the animals' disruptive coloration making them almost invisible. But when the sun was lower, both in the morning and evening, the sitting bird was more conspicuous. However on all but 4 occasions the bird walked directly from the tap to the nest, so when the bird left the tap it was an indication that a take-over was imminent and this could be watched for. We therefore obtained timings of the duty periods but have not been able to add to our previous notes on the behaviour of the bird on duty on or around the nest.

A bird was always present on the nest when watching was begun (except on 11/v), but on 8 occasions, including 10/v, the nest was uncovered when watching ceased.

During these observation periods, the female was seen to take over incubation on 43 occasions and the male on 42 occasions. During any one observation period the number of times the two sexes assume duty cannot differ by more than one, because these alternate, but though the difference between the totals for the two sexes will be thus reduced, the virtual equality observed is more than a tautology.

When a bird was relieved from nest 3′, on all but 10 occasions (including the 3 last on 10/v and 5 others at the end of the watching period) it approached the tap usually at a brisk walking pace, but in strong sunshine it sometimes ran and jumped or stumbled over the rim of the pavement. They never flew. Once in the tap area, usually on the pavement, it groomed with high intensity usually drinking immediately on arrival. The choice of the tap and its surroundings as an off-duty resting place during a period of higher temperatures, and the introduction of repeated drinking sooner or later among the grooming movements, confirms our previous interpretation of this grooming as a method of lowering the body temperature by evaporation. The animal usually walked in and out of the tap pavement and the various regions of shade and eddies between its eastern edge and the hedge between the two gardens. The grooming gradually became more desultory as the inter-duty period progressed, but on 58 occasions the animals began to crouch on the wet

TABLE II

TIME BETWEEN LAST WETTING AND ASSUMING DUTY

minutes	<1	1	2	3	4	5	6	7	8	9	10	11	12	15	29	36	49	not timed	Total	mean	variance
♀ certain	3	10	1	1	1		3			1	1		1	2			1		25		
♀ presumed	1	2				1												1	5		
♀ Total	4	12	1	1	1	1	3	0		1	1		1	2			1	1	30	5.31	90.44
♂ certain	0	5	7	6	3	3	0	3	3	0	0	1			1	1	0		33	5.61	53.31

pavement, or in the shallow water sometimes bending forward so that their breasts as well as their bellies were wetted. Usually they walked a few steps in this position. The belly feathers were erected during these movements and the dirty water could be seen smeared on them. This *crouching* which may occur only once or may be repeated 20 times usually occurred only in the later part of an off-duty period. The exceptions were few and during the hottest periods when the animals in their hurry fell over the rim of the pavement and splashed about in the water immediately. While performing these crouches, the animals sometimes disappeared behind the plants growing by the drain often for several minutes and then walked calmly into view from behind them. At these times we have *presumed* that the birds were sitting down in the relatively deeper water behind the plants. On the five occasions when only disappearances and no crouches were recorded in off-duty periods, all for the female, we have presumed that she wet her belly, because such a sitting down would be the most efficient method of achieving this.

A belly-wetting crouch was frequently the last act performed in the tap-region before the birds stepped off the south rim of the pavement to begin the very characteristic march to the nest. The time taken for this was very variable, but it could be brisk enough to be completed in under a minute. Both birds took a rather stereotyped curved path going considerably to the west of the straight line between the tap and the nest. Table II gives the distributions of the time between the last crouch, or failing this the last reappearance from the drain region, and the time at which the bird stepped onto the nest. From this table can be seen how few were the occasions when the period between the wetting and the assumption of duty was so long that it was doubtful if the bird was wet when it took over the nest.

No differences were observed between the frequencies with which the male and the female wet their bellies either as the incubation period advanced, or as the ground or air temperatures rose, or at different hours of the day. Therefore, in Tables III and IV, the figures for the two sexes are added together. The figures are arranged in Table III according to ascending values of ground temperatures. These were taken so as to be as similar as possible to those to which the nest was exposed. The maximum air temperatures and the humidities (at some time between 08.00 and 10.00) being collected for another purpose were taken indoors in a non-airtight and frequently opened cupboard. These are thus only correlated with the conditions surrounding the eggs, though it should be stressed that in the tropics the interiors of non-airconditioned houses are much more open and ventilated than in temperate climates. From this table it is clear that the frequency of belly-wetting, and therefore egg-wetting, increases with rise in temperature. This is confirmed by Table IV in which the data are rearranged according to the hours of

TABLE III

Temperature °C.		humidity indoors	date	watching time		Assumptions of duty				
Ground	Max. indoors			hrs.	min.	♀	♂	after wetting	without wetting	proportion after wetting
44.5	33.5	74	28/iv	5	31	2	3	3	2	.6
49	31.5	74	26/iv	4	12	1	1	0	2	0
50.5	33	77	29/iv	6		2	2	3	1	.75
52	33.5	71	7/v	6		3	3	5	1	.83
53	32.5	74	27/iv	5	58	1	1	2	0	1.0
54	35	73	6/v	6		3	3	5	1	.83
55.5	33.5	77	30/iv	5	39	2	2	1	3	.25
56	34.5	71	2/v	6		3	3	4	2	.67
56	34	68	3/v	6		3	2	1	4	.2
57	35	73.5	4/v	6		3	3	4	2	.67
57	34.5	68	5/v	5	57	3	2	4	1	.8
57.5	34.5	71	1/v	6		3	2	5	0	1.0
58	34.5	74	9/v	6		5	4	8	1	.89
58	35.5	77	10/v	5	26	6	7	11	2	.85
60	33.5	75	8/v	6		3	4	7	0	1.0
			Total..	86	43	43	42	63	22	
47.5	35.5	72.75	11/v	4	33	0	0	0	0	..

TABLE IV

hour of day	time watched 26/iv—10/v		Change-overs				
	hrs.	min.	♀	♂	with wetting	without wetting	wetting / Total
10.30—	13	03	6	5	5	6	.45
11.30—	14	12	7	9	12	4	.75
12.30—	15		9	7	12	4	.75
13.30—	15		7	8	14	1	.93
14.30—	15		10	6	14	2	.875
15.30—	14	28	4	7	6	5	.55
Total	86	43	43	42	63	22	

the day showing that the frequency has a peak during the period just after noon.

To sum up : pair 3 who did not damp their first clutch of eggs early in the season repeatedly damped their second clutch produced when the season was more advanced and the weather was, on the whole, hotter. However the relationship between the temperature and egg-wetting is not simple. Though, during the incubation of clutch 3, 54°C. was the highest ground temperature recorded, on no fewer than 21 days out of the 28 days during which this nest was watched temperatures of 44.5°C. and higher were recorded. As the eggs of clutch 3′ were damped at these temperatures this behaviour cannot be a direct response to a ground temperature above a critical value.

In 1963 the female of pair 1 damped her feathers twice within the hour following the removal of the last egg-shell from the nest, but not subsequently. The young, who were still in the nest, were not seen to suck them. It is possible that this continuation of damping after all the eggs were hatched was a lag persisting during the shift to behaviour appropriate to the chick-shepherding stage of parental activities and may be compared with the observation that the last time a parent stepped off nest 3, this was accompanied by nest-building (Jayakar & Spurway 1965). After they deserted nest 3′, neither parent was seen to approach the tap or perform any action in the tap-region, thus suggesting that none of its previous valence remained. This desertion of both sites simultaneously, which probably occurred on the late afternoon of 10/v, was quite complete by the morning of 11/v when the parents and three chicks were observed many times before systematic observation was begun. There was no parental reaction when the unhatched egg was collected at 14.00. However this observation that belly-damping ceases at nest desertion, feathers not being used to carry water to the young birds as in *Pterocles* spp. (Marchant 1961; 1962) is not as definitive as could be wished, because the storm on the evening of 10/v had caused a considerable drop in the temperatures on 11/v (Table III). It is still possible therefore that water for drinking would be carried to the young at higher circumambient temperatures. It is also possible that the temperature thresholds for watering mobile chicks that can, and do, seek shade might be higher than that for damping stationary exposed eggs.

In our previous paper we discussed comparable behaviour in other species. We have since discovered two other descriptions, both of behaviour much more similar to that here described, and both occurring in species which Bock (1958) now includes in the genus *Vanellus* with *malabaricus*, which he considers, incorrectly, to be an African species. Owing to the kindness of Rev. W. Serle, we have read his account (1939) of a colony of *Xiphidiopterus albiceps* in Northern Nigeria cooling their eggs by wetting their underparts. Crossley (*in litt.*) observed individuals of *Hoplopterus spinosus* performing the same action in July 1952 in Egypt. In contrast, Helversen (1963) observed during May 1962 in north-east Greece that individuals of this species sat continuously on their nest throughout the night, approximately from 18 to 09 hours, and left these unattended for considerable periods during the rest of the day. Therefore, like *V. malabaricus*, *V. spinosus* varies its incubation behaviour according to the demands put on it by the environment. In the northern part of the range of the species, incubation is primarily to warm the eggs, whereas in hotter regions at least on some occasions it can be used to cool them. We thank James Ferguson-Lees Esq. for introducing us to Roy Crossley Esq.

SUMMARY

Seven clutches were laid by 5 (or 4) pairs of *Vanellus malabaricus* in an area of 15 hectares or 37 acres during the 1964 breeding season. The incubation period ranged from 26-29 days. The earliest that a chick was seen to fly was 32 days after hatching.

Young from two clutches laid during the same season, by the same hen, in different scrapes, were raised. A chick of a first clutch, already able to fly, accompanied its parents while they were incubating their second clutch, and was driven from the territory by both physical attacks and agonistic behaviour.

A scrape was re-used the same season, but it is not known whether the two clutches were laid by the same hen.

The territories in our area were over 2.5 hectares. Unlike those of *V. vanellus*, they were contiguous and the adults and chicks fed in them exclusively. Their boundaries altered during a season, as areas were ceded, perhaps temporarily, to later arriving pairs.

During the hotter parts of the day, and the season, one pair of parents cooled the eggs of their second clutch by wetting their breasts and bellies in standing water immediately before walking on to the nest. This behaviour was not performed during the incubation of their first clutch.

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Note added in proof

Vince (*Nature* **203** : 1192-3) has demonstrated that eggs of *Colinus virginianus* in synthetic clutches, the members of which were put together only after different periods of artificial incubation, hatched at approximately the same time.

K. R. L. Hall (*Ostrich*, Maart 1964 : 3-16) has seen a first brood young of *Vanellus* (*Hoplopterus*) *armatus* stay with its parents until the second brood was hatched. It was then driven away, Hall thinks because of the increased aggressiveness of the parents to any bird that approaches them at this time.

Mr. Crossley's observations on *V. spinosus* have been published (*Brit. Birds* **57** : 515-6). Hall (loc. cit.) did not report egg-wetting in the closely related, perhaps even conspecific, *armatus* which he observed in Cape Town which, like Greece, has a 'mediterranean' climate.

Thanks to the contributors to the *Newsletter for Birdwatchers*, Bombay, we learn that chick-wetting has also been observed in *Bubulcus ibis* in West Pakistan (J. O. Wright, *in litt.*) and egg-wetting in the following species : *Glareola lactea*, *Charadrius alexandrinus*, *Himantopus himantopus*, and *Vanellus indicus*. These last four, together with *Sterna albifrons*, in which it has previously been recorded, were the only species found by R. S. Dharmakumarsinhji breeding on an exposed island during May 1962 in Saurashtra (*Pavo* **2** : 1-11). Shri Dharmakumarsinhji (*in litt.*) has seen it performed by *Esacus magnirostris* and several other resident plovers. It seems therefore a widely distributed capacity.

S. D. J.
H. S.

On the 'Sudano-Deccanian' Floral Element

BY

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(*With a map and one plate containing* 8 *graphs*)

Every natural phytogeographic province is individualized by its special floristic assemblage. This characteristic flora of a phytogeographic province constitutes the floral element of that territory.

The floral elements which concern the dry parts of India fall into two groups :

(1) ' North African-Indian desert ' element (cf. Blatter *et al.* 1929) or the ' Saharo-Sindian ' element (cf. Eig 1931), the characteristic area of which includes the Sahara, northern Arabia, Mesopotamia, Persia, and the desertic north-west part of the Indian sub-continent.

As examples of this element may be cited *Farsetia aegyptiaca* Turr., *Fagonia cretica* L., *Heliotropium undulatum* Vahl, *Launaea glomerata* (L.) Hook., *Lycium barbarum* L., *Malcolmia strigosa* Boiss., *Oligomeris subulata* (Del.) Boiss., *Peganum harmala* L., and *Periploca aphylla* Dcne.

(2) ' Tropical and North African-Indian desert ' element (cf. Blatter *et al.* 1929) which comprises Senegambia, Sudan, Abyssinia, Eritrea, Somaliland, southern Arabia, Socotra and sends representatives into the dry parts of India especially in the north-west.

The following species exemplify this element : *Acacia senegal* Willd., *Balanites aegyptiaca* (L.) Del., *Capparis decidua* (Forsk.) Pax, *Cleome brachycarpa* Vahl, *Corchorus depressus* (L.) Stocks, *Dicoma tomentosa* Cass., *Grewia tenax* (Forsk.) Fiori, *Melhania denhami* Br., *Polygala irregularis* Boiss., and *Zygophyllum simplex* L.

This element is also known under the name of ' North African *steppe* ' element. However, it may be pointed out that this term is not thoroughly justifiable, because the element includes species of savanna and thorn-forest and not of a true steppe. Secondly, steppe vegetation type is an expression of cold semi-arid climate and not of warm tropical. Trochain (1954) has proposed the term ' pseudo-steppe ' for the so-called steppic vegetation of north Africa because the true climax steppe is restricted to the chernozem soil.

Eig (1931) has designated the term ' Sudano-Deccanian ' for this element, giving the following limits to the Sudano-Deccanian territory.

Throughout the breadth of Africa between the Sahara and the tropical forest region extends a vast area of savanna and steppe which extends from Senegambia to Ethiopia and Eritrea ; beyond the Red Sea this territory continues in tropical Arabia and seems to terminate in India where certain parts, especially of the Deccan, show many ecological and floristic affinities with Sudanian-Ethiopian savannas and steppes.

An analysis of the floral elements of the dry parts of India carried out by me (Meher-Homji 1962) offers some objections to the above statement of Eig and to the validity of the term ' Sudano-Deccanian ' floral element, in that the analogies between the above-mentioned parts of Africa and the Deccan are not so pronounced.

Two zones of dry (semi-arid) climates are recognized in India, one in the north contiguous to the desert of Thar, extending into Rajasthan, the Punjab, parts of Uttar Pradesh, and north Gujarat. The other semi-arid zone, situated in the south, includes the Deccan plateau and parts of Coimbatore, Ramanathapuram, and Tirunelveli districts of Madras.

The strength of the ' Tropical and North African-Indian desert ' (the so-called Sudano-Deccanian) element in the entire southern semi-arid zone including the Deccan is only 2.6% (Meher-Homji 1962). The strength of this element is two times higher (5.4%) in the northern semi-arid zone. Thus the concentration of this element is in the northern semi-arid zone rather than in the Deccan.

Further, the bioclimatic map reveals a continuous belt of tropical sub-desertic bioclimate (type 5) almost throughout all Senegambia, Sudan, Ethiopia, southern Arabia, and parts of Rajasthan and the Punjab. This sub-desertic climate does not enter the Deccan.

It is also interesting to compare the ombrothermic[1] diagrams of the stations of the Sudanese region (Graphs 1 to 4 of Nema, Timbuctoo, El Fasher, and Kidal) with those of Rajasthan (Graphs 5, 6 of Bikaner and Jodhpur) which resemble each other so much. On the other hand, the diagrams of the stations of the Deccan (Graphs 7 and 8 of Malegaon and Hyderabad Dn.) differ considerably from those of the Sudanese stations. Therefore, from the climatic point of view, also, the Deccan or the southern semi-arid zone has little in common with the Sudanese region. The region which presents greater similarity with the Sudanese zone is the northern semi-arid zone of India both from the climatic and the floristic view-points : climatically by resemblances in the bioclimatic conditions and ombrothermic diagrams, floristically by higher percentage of the ' Tropical and North African-Indian desert ' element.

Therefore, in my opinion, the term ' Sudano-Deccanian ' of Eig is not justifiable. It would be more reasonable to speak of this element

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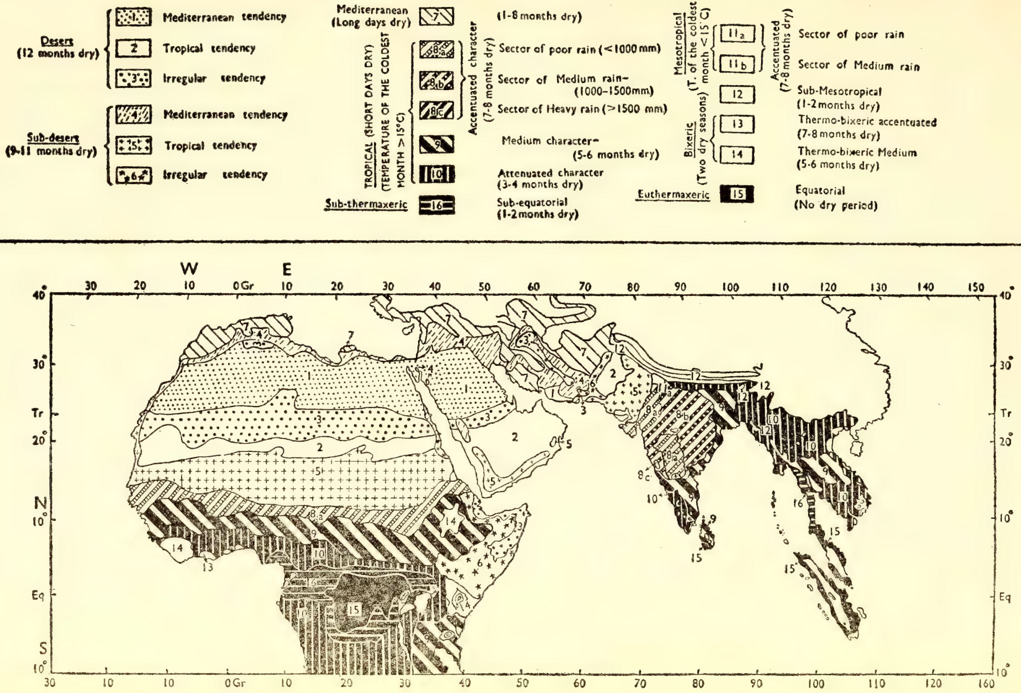
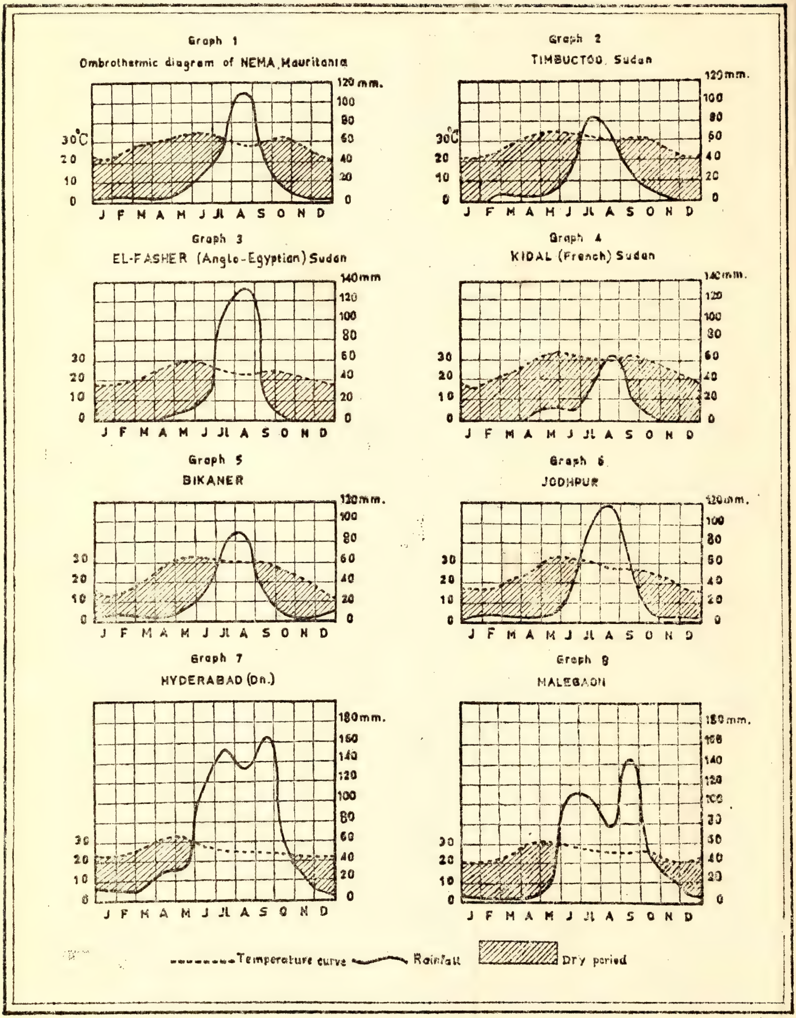
[1] Ombros=rain. For details of ombrothermic diagrams reference may be made to Bagnouls, & Meher-Homji (1959, p. 228). V.M.M.-H.

MAP I

BIOCLIMATES OF AFRO-ASIAN CONTINENTS (After Meher-Homji. 1960)


Desert (12 months dry)
1 Mediterranean tendency
2 Tropical tendency
3 Irregular tendency
Sub-desert (9-11 months dry)
4 Mediterranean tendency
5 Tropical tendency
6 Irregular tendency
Mediterranean (Long days dry)
7 (1-8 months dry)
TROPICAL (SHORT DAYS DRY) (TEMPERATURE OF THE COLDEST MONTH > 15°C)
Accentuated character (7-8 months dry)
8a Sector of poor rain (<1000 mm)
8b Sector of Medium rain-(1000-1500mm)
8c Sector of Heavy rain (>1500 mm)
9 Medium character-(5-6 months dry)
10 Attenuated character (3-4 months dry)
Sub-thermaxeric
16 Sub-equatorial (1-2 months dry)
Mesotropical (T. of the coldest month < 15°C)
Accentuated (7-8 months dry)
11a Sector of poor rain
11b Sector of Medium rain
12 Sub-Mesotropical (1-2 months dry)
Bixeric (Two dry seasons)
13 Thermo-bixeric accentuated (7-8 months dry)
14 Thermo-bixeric Medium (5-6 months dry)
Euthermaxeric
15 Equatorial (No dry period)
W
E
30
20
10
0Gr
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
40°
30°
Tr
20°
N
10°
Eq
S
10°
160



Ombrothermic diagrams of the Sudanese region (graphs 1 to 4), Rajasthan (graphs 5 and 6), and the Deccan (graphs 7 and 8) as ' Sudano-Rajasthanian ', because it is the semi-arid Rajasthan which offers closer analogies with the Sudan region by consideration of the bioclimatic conditions and the ombrothermic diagrams.

We have one more reason in changing the term Sudano-Deccanian to Sudano-Rajasthanian and that is on geographical grounds. The entry of the ' Tropical and North African-Indian desert ' element directly into the Deccan without penetrating the northern zone does not seem likely, because of the water barrier provided by the Arabian Sea and secondly because of the mountain barrier of the Western Ghats. The entry of this element into the Deccan seems possible only through the northern zone, for it is this zone that is continuous with the Sudan region through Pakistan, Iran, and Arabia.

Finally, we may point out that the terminology of ' Sudano-Deccanian ' element completely breaks down if we consider the distribution of the species cited by Eig (1931, 1939) as ' Sudano-Deccanian '. As examples may be mentioned *Acacia albida*, *A. laeta*, *A. seyal*, *Aristida sieberiana*, *Ficus sycomorus*, *Moringa aptera*, and *Zizyphus spina-christi*, which never occur in the Deccan.

As a matter of fact Eig (1931, p. 131) himself admitted the relative floristic individuality of the Deccan from the rest of the Sudanian territory.

Gruenberg-Fertig (1954) also pointed out the occurrence of only a very negligible percentage of the flora of Sudan and SW. Arabia in the Deccan peninsula and on this ground she suggested the separation of the African and Arabian parts of Eig's ' Sudano-Deccanian ' region from the Deccan as the Sudanian region.

It is worth mentioning that the eastern limit of this Sudanian region, which comprised two sub-regions viz. (1) West Sudanian and (2) Eritraeo-Arabian, was judged to stretch up to Baluchistan through the south-western corner of Arabia and southern Iran (Zohary 1962). My present investigation shows that the eastern boundary of the Sudanian region extends up to Rajasthan.

In the framework of the present study we may also verify the validity of the term Saharo-Sindian element. On floristic basis, in the Indus delta (Sind) of 279 species that make up its flora 60 (21.5%) are of North African-Indian desert (' Saharo-Sindian ') element, common to the deserts of north Africa and India (cf. Blatter, McCann, & Sabnis 1929). In the Thar or the Indian Desert, out of 440 indigenous species 71 (16.1%) are Saharo-Sindian (cf. Blatter & Hallberg 1918). On climatic grounds, Sind and Thar are characterized by a desertic bioclimate like the Sahara (Map). In view of the high percentage of the element (16 to 21.5%) and of resemblances in the climatic conditions, the original proposal of the term Saharo-Sindian seems appropriate.

SUMMARY

It is suggested that the term 'Sudano-Rajasthanian' floral element is more appropriate than the term 'Sudano-Deccanian' proposed by Eig (1931). The arguments in favour of this change are advanced on floristic and bioclimatic grounds.

ACKNOWLEDGEMENTS

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Zoogeography of Termites of Assam Region, India, with remarks on Speciation

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I. INTRODUCTION

The 'Assam Region' of eastern India covers an area of about 1,04,048 sq. miles and is composed of five administrative units, namely the Assam State (50,143 sq. miles), and four centrally administered areas called the North-East Frontier Agency (NEFA) (34,969 sq. miles), Manipur (8628 sq. miles), the Naga Hills and Tuensang Area (6276 sq. miles), and Tripura (4032 sq. miles). It presents a remarkable topographic and ecological variety. Over one-half its area is covered with hills and mountains, some of them of great height and perpetually snow-bound. The remaining areas are either cultivated or covered with dense evergreen forests. A detailed account of the plant community in a restricted area (the Imphal Valley, Manipur) has been given by Roonwal (1949*a*, pp. 110-116). The climate is 'humid tropical' in the plains, and 'temperate' in the hills. The rainfall is heavy all over the area.

The termite fauna of the Assam Region has until recently been studied in a more or less desultory way. The following authorities have contributed to its study: Holmgren (1913), Silvestri (1914), Gardner (1944), Snyder (1949), and more recently Roonwal & Pant (1953), Roonwal & Sen-Sarma (1956, 1960), and Roonwal & Chhotani (1959-62). Snyder (1949) in his world catalogue listed only eight species from the Assam Region. As a result of intensive work subsequently, Roonwal & Chhotani (1962*a*) listed 34 species, 13 of which were new. This last paper also gives a map of the area and a full list of references on the termites of that region.

In the present paper are discussed the zoogeographical significance of the termite fauna of the Assam Region and its bearing on the speciation problem.

II. TAXONOMIC DISTRIBUTION

Three of the known 6 families of living termites are represented in the Assam Region, viz. the families Kalotermitidae, Rhinotermitidae, and Termitidae. The families not represented are: Mastotermitidae (Australian only), Hodotermitidae, and Indotermitidae (the peculiar family recently described by Roonwal & Sen-Sarma (1960) from Burma; *vide* also Roonwal 1958, for a preliminary account). A total of 16 genera and 34 species is represented (Table), the distribution of the genera and the number of species in each of them being as follows:

Fam. I. KALOTERMITIDAE (1 subfamily, 2 genera, 2 species)	
Subfam. (i) KALOTERMITINAE	
1. *Neotermes* Holmgren	1 sp.
2. *Cryptotermes* Banks	1 sp.
Fam. II. RHINOTERMITIDAE (3 subfamilies, 3 genera, 6 species)	
Subfam. (i) HETEROTERMITINAE	
3. *Reticulitermes* Holmgren	2 spp.
Subfam. (ii) COPTOTERMITINAE	
4. *Coptotermes* Wasmann	3 spp.
Subfam. (iii) RHINOTERMITINAE	
5. *Parrhinotermes* Holmgren	1 sp.
Fam. III. TERMITIDAE (4 subfamilies, 11 genera, 26 species)	
Subfam. (i) AMITERMITINAE	
6. *Anoplotermes* Müller	1 sp.
7. *Speculitermes* Wasmann	1 sp.
8. *Synhamitermes* Holmgren	1 sp.
9. *Microcerotermes* Silvestri	1 sp.
Subfam. (ii) TERMITINAE	
10. *Pseudocapritermes* Kemner	1 sp.
11. *Capritermes* Wasmann	2 spp.
Subfam. (iii) MACROTERMITINAE	
12. *Macrotermes* Holmgren	1 sp.
13. *Odontotermes* Holmgren	8 spp.
14. *Hypotermes* Holmgren	3 spp.
15. *Microtermes* Wasmann	3 spp.
Subfam. (iv) NASUTITERMITINAE	
16. *Nasutitermes* Dudley	4 spp.
Total	34 spp.

As is usual in the Indo-Malayan Region, the family most richly represented is the Termitidae, with 4 subfamilies, 11 genera, and 26 species (comprising 69% of the genera and 76% of the species known from the Assam Region). The genus best represented is *Odontotermes* (with 8 species or 24% of the total). The three closely allied genera *Odontotermes*, *Hypotermes*, and *Microtermes* contain among themselves 14 species or 41% of the total. The genus *Nasutitermes* is also well represented, with 4 species (12% of the total).

III. Zoogeography and Speciation
(Table)

For a zoogeographical analysis, the species are arranged below under the following seven categories, while a more detailed distribution is given in the Table at pp. 26-31 below :

Category	No. of species (and % of total : 34)
(i) Species endemic to the Assam Region (Assam State, NEFA, Naga Hills and Tuensang Area, Manipur, and Tripura)	20 (58·8%)
(ii) Species common with peninsular India (below *c.* 20°N. latitude) only	none
(iii) Species common with whole of India (including peninsular India) and with E. Bengal (E. Pakistan) only	6 (17·6%)
(iv) Species common with Burma only	1 (3%)
(v) Species common with Ceylon only	none
(vi) Species common with the Indo-Malayan Region (India, Pakistan, Ceylon, Burma, Malaya, Indonesia), either whole or in part	16 (47%)
(vii) Species common with the Palaearctic region (central China) only	1 (3%)

(i) *Species endemic to the Assam Region* (*Assam State, NEFA, Naga Hills and Tuensang Area, Manipur and Tripura*) :

1. *Neotermes megaoculatus lakhimpuri* Roonwal & Sen-Sarma
2. *Reticulitermes saraswati* Roonwal & Chhotani
3. *Parrhinotermes khasii* Roonwal & Sen-Sarma
4. *Anoplotermes shillongensis* Roonwal & Chhotani
5. *Speculitermes cyclops rongrensis* Roonwal & Chhotani
6. *Pseudocapritermes tikadari* Roonwal & Chhotani
7. *Capritermes latignathus durga* Roonwal & Chhotani
8. *Macrotermes khajuriai* Roonwal & Chhotani
9. *Odontotermes assamensis* Holmgren
10. *Odontotermes flavomaculatus* Holmgren & Holmgren
11. *Odontotermes giriensis* Roonwal & Chhotani
12. *Odontotermes horai* Roonwal & Chhotani
13. *Odontotermes kapuri* Roonwal & Chhotani
14. *Hypotermes nongpriangi* Roonwal & Sen-Sarma
15. *Microtermes imphalensis* Roonwal & Chhotani
16. *Microtermes umsae* Roonwal & Chhotani
17. *Nasutitermes cherraensis* Roonwal & Chhotani
18. *Nasutitermes garoensis* Roonwal & Chhotani
19. *Nasutitermes kali* Roonwal & Chhotani
20. *Nasutitermes moratus* (Silvestri)

(ii) *Species common with peninsular India (below c. 20° N. latitude) only :*

None

(iii) *Species common with whole of India (including peninsular India) and with E. Bengal (E. Pakistan) only :*

1. *Neotermes megaoculatus* Roonwal & Sen-Sarma
   (The subspecies *N. m. lakhimpuri* R. & S. is confined to Assam.)
2. *Cryptotermes bengalensis* Snyder[1]
3. *Coptotermes heimi* (Wasmann)
4. *Synhamitermes quadriceps* (Wasmann)
5. *Capritermes dunensis* Roonwal & Sen-Sarma
6. *Odontotermes parvidens* Holmgren & Holmgren

(iv) *Species common with Burma only :*

Coptotermes gestroi Wasmann

(v) *Species common with Ceylon only :*

None

(vi) *Species common with the Indo-Malayan Region (India, Pakistan, Ceylon, Burma, Malaya, Indonesia), either whole or in part :*

1. *Neotermes megaoculatus* Roonwal & Sen-Sarma
   (The subspecies *N. m. lakhimpuri* R. & S. is confined to Assam.)
2. *Cryptotermes bengalensis* Snyder
3. *Coptotermes gestroi* Wasmann
4. *Coptotermes heimi* (Wasmann)
5. *Coptotermes travians* Haviland
6. *Speculitermes cyclops* Wasmann (The subspecies *S. c. rongrensis* Roonwal & Chhotani is confined to Assam.)
7. *Synhamitermes quadriceps* (Wasmann)
8. *Microcerotermes heimi* Wasmann
9. *Capritermes dunensis* Roonwal & Sen-Sarma
10. *Capritermes latignathus* Holmgren (The subspecies *C. l. durga* Roonwal & Chhotani is confined to Assam.)
11. *Odontotermes feae* (Wasmann)
12. *Odontotermes horni* (Wasmann)
13. *Odontotermes parvidens* Holmgren & Holmgren
14. *Hypotermes obscuriceps* (Wasmann)
15. *Hypotermes xenotermitis* (Wasmann)
16. *Microtermes anandi* Holmgren

(vii) *Species common with Palaearctic region only*

Reticulitermes chinensis Snyder (Central China)

It will be seen from the analysis given above that the general zoogeographical facies of the termite fauna of the Assam Region is, as is to be expected, overwhelmingly Indo-Malayan. Out of the 34 species occurring in the Region, the only one which shows some Palaearctic affinities is *Reticulitermes chinensis* Snyder (syn. *R. assamensis* Gardner) which has been recorded, besides Assam, from the Szechuan Province in central China.

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[1] Ahmad (1952, *Proc. 4th Pak. Sci Conf.*, Peshawar, Pt. 3, p. 71) regards *C. bengalensis* as a synonym of *C. havilandi* (Sjöstedt).

CAUSES OF SPECIATION

A remarkably large proportion of species, 20 out of 34 or 58·8%, are endemic to the Assam Region. This indicates a high rate of speciation in this region which is ecologically characterized by either dense evergreen forests or hills cut up into innumerable small valleys. In both these ecological situations, the movements of termites (even of the winged ones) are relatively restricted by the dense forests or by high ranges. As a consequence, the termites are cut up into small or medium-sized populations which are confined to their patch of dense forest or their valley, and opportunities of inter-population mixing are few, i.e. the ' migration pressure ' is low. Thus, well-known ' population effects' are called into play in which, as has been shown in medium populations [the Wright-Dubinin Effect, *vide* Dubinin (1931), Dubinin & Romaschoff (1932), and Wright (1931-46)] and in small populations (the Roonwal Effect, *vide* Roonwal 1953, 1954) the variation-intensity is increased and the process of speciation speeded up (for a discussion of these effects, *vide* Roonwal 1947-54).

Of the non-endemic termite fauna, none is common with peninsular India only, and with Ceylon only ; 6 species (17.6%) are common with the whole of India (including E. Pakistan) only, 1 (3%) common with Burma only, and 16 (47%) common with the Indo-Malayan Region (either whole or in part). The species which are rather widely distributed over the Indo-Malayan Region are the following :

1. *Coptotermes gestroi* Wasmann (India ; Burma)
2. *Coptotermes heimi* (Wasmann) (India ; W. Pakistan ; also probably middle Java, Indonesia)
3. *Coptotermes travians* Haviland (India ; Malaya ; Indonesia)
4. *Microcerotermes heimi* Wasmann (India ; Ceylon)
5. *Odontotermes feae* (Wasmann) (India ; Burma)
6. *Odontotermes horni* (Wasmann) (India ; Ceylon)
7. *Hypotermes obscuriceps* (Wasmann) (India ; Ceylon)
8. *Hypotermes xenotermitis* Wasmann (India ; Burma)
9. *Microtermes anandi* Holmgren (India ; Ceylon).

Three genera call for special comment :

Genus *Parrhinotermes* Holmgren is a small one comprising only 6 species, of which 5 are Indo-Malayan (India, Malaya, Indonesia) and one Australian. The single species from India, *P. khasii* R. & S., is from Assam and was described by Roonwal & Sen-Sarma (1956)—this was the first record of the genus from Indian territory.

Genus *Anoplotermes* Müller is characterized by the absence of the soldier caste, only workers and alates (reproductives) being present. It is a large genus, containing about 45 species of which the majority (73%) are Neotropical (South and Central America), a few (25%) Ethiopian (Africa), and only one *A. shillongensis* R. & C., which was recently discovered by Roonwal & Chhotani (1959, 1960*a*), is Indian (from Assam).

Like *Anoplotermes*, the closely allied but much smaller genus *Speculitermes* Wasmann is characterized by the virtual absence of the soldier caste. It has 7 species of which 4 (or 57·1%) are Neotropical and 3 (42·9%) Indo-Malayan. One subspecies, *S. cyclops rongrensis* Roonwal & Chhotani, is represented in Assam.

IV. SUMMARY

1. The Assam Region of eastern India, comprising the five administrative units of Assam State, North-East Frontier Agency, Manipur, the Naga Hills and Tuensang Areas, and Tripura, is characterized by a remarkable variety of ecological environment. The plains and the lower areas are ' humid-tropical ' and are either cultivated or covered with dense evergreen forests. The hilly areas (which comprise over one-half the total area) are ' temperate '. The rainfall is heavy all over the area.

2. The termite fauna of the Assam Region has been studied fairly intensively in recent years, and a total of 16 genera and 34 species recorded.

3. Three termite families are represented, viz. Kalotermitidae, Rhinotermitidae, and Termitidae. The Termitidae contains the largest number of genera and species—11 genera (69%) and 26 species (76%).

4. The genus *Odontotermes* contains the largest number of species (8, or 24%).

5. The termite fauna has been analysed zoogeographically. A remarkably high proportion (20 species, or 58.8%) of the fauna is endemic, and has not been recorded elsewhere. No species is common with peninsular India only or with Ceylon only, and one species is common with Burma only. Six species (17.6%) are common with the Indian Region as a whole (including E. Bengal in E. Pakistan), and 16 species (47%) are common with the Indo-Malayan Region. Only one species (3%) is common with the Palaearctic Region (central China) only.

6. It is suggested that the very high proportion of endemic species (about 59%) is indicative of a high rate of speciation in the region. It is further suggested that this is due to the peculiar ecological conditions (dense forests and numerous hill ranges and valleys) which tend to cut up the distribution into small, semi-isolated populations, and this condition accelerates the variation-intensity in terms of the Wright-Dubinin and the Roonwal Effects.

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TABLE

GEOGRAPHICAL DISTRIBUTION OF THE TERMITE SPECIES SO FAR RECORDED FROM THE ASSAM REGION

+ Present ; — Absent

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3) and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
Fam. I. KALOTERMITIDAE										
1. *Neotermes megaoculatus lakhimpuri* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	The typical subspecies, *N. m. megaoculatus* Roonwal & Sen-Sarma, occurs in the foothills of the western Himalayas, at Dehra Dun (U.P., India)
2. *Cryptotermes bengalensis* Snyder [= ? *C. havilandi* Sjdt.]	+	—	+ (W. Bengal & E. Pakistan)	—	—	—	—	—	Indo-Malayan	..
Fam. II. RHINOTERMITIDAE										
3. *Reticulitermes chinensis* Snyder (syn. *R. assamensis* Gardner)	+	—	—	—	—	—	+ (Szechuan Province)	—	Indo-Malayan (Also Palaearctic)	..

4. *Reticulitermes saraswati* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
5. *Coptotermes gestroi* Wasmann	+	—	—	—	+	—	—	—	Indo-Malayan	..
6. *Coptotermes heimi* (Wasmann) (syn. *C. parvulus* Holmgren)	+	+	+ (India ; W. Pakistan)	—	—	? (Middle Java—needs confirmation)	—	+ (W. Pakistan)	Indo-Malayan	Widely distributed in all-India and W. Pakistan. Probably also in middle Java (Indonesia)—needs confirmation.
7. *Coptotermes travians* Haviland	+	+ (Puri, Orissa)	+ (W. Bengal ; E. Pakistan)	—	+	+ (Malaya ; Indonesia)	—	—	Indo-Malayan	Apparently an eastern species—east of Puri (Orissa), long. *c.* 85°E.
8. *Parrhinotermes khasii* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	The genus *Parrhinotermes* is largely Indo-Malayan (5 species : India, Malaya, Indonesia), with one Australian species. The record by Roonwal & Sen-Sarma (1956) is the first record of the genus from India.
Fam. III. TERMITIDAE										
9. *Anoplotermes shillongensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The record of Roonwal & Chhotani (1959 ; and 1960, 1962*a*, *c*) is the first record of the genus *Anoplotermes* from India. The genus is largely neotropical (South America and Central America) and Ethiopian (Africa).

TABLE

GEOGRAPHICAL DISTRIBUTION OF THE TERMITE SPECIES SO FAR RECORDED FROM THE ASSAM REGION

+ Present ; — Absent

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3) and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
Fam. I. KALOTERMITIDAE										
1. *Neotermes megaoculatus lakhimpuri* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	The typical subspecies, *N. m. megaoculatus* Roonwal & Sen-Sarma, occurs in the foothills of the western Himalayas, at Dehra Dun (U.P., India)
2. *Cryptotermes bengalensis* Snyder [= ? *C. havilandi* Sjdt.]	+	—	+ (W. Bengal & E. Pakistan)	—	—	—	—	—	Indo-Malayan	..
Fam. II. RHINOTERMITIDAE										
3. *Reticulitermes chinensis* Snyder (syn. *R. assamensis* Gardner)	+	—	—	—	—	—	+ (Szechuan Province)	—	Indo-Malayan (Also Palaearctic)	..
4. *Reticulitermes saraswati* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
5. *Coptotermes gestroi* Wasmann	+	—	—	—	+	—	—	—	Indo-Malayan	..
6. *Coptotermes heimi* (Wasmann) (syn. *C. parvulus* Holmgren)	+	+	+ (India ; W. Pakistan)	—	—	? (Middle Java—needs confirmation)	—	+ (W. Pakistan)	Indo-Malayan	Widely distributed in all-India and W. Pakistan. Probably also in middle Java (Indonesia)—needs confirmation.
7. *Coptotermes travians* Haviland	+	+ (Puri, Orissa)	+ (W. Bengal ; E. Pakistan)	—	+	+ (Malaya ; Indonesia)	—	—	Indo-Malayan	Apparently an eastern species—east of Puri (Orissa), long. *c.* 85°E.
8. *Parrhinotermes khasii* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	The genus *Parrhinotermes* is largely Indo-Malayan (5 species : India, Malaya, Indonesia), with one Australian species. The record by Roonwal & Sen-Sarma (1956) is the first record of the genus from India.
Fam. III. TERMITIDAE										
9. *Anoplotermes shillongensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The record of Roonwal & Chhotani (1959 ; and 1960, 1962*a*, *c*) is the first record of the genus *Anoplotermes* from India. The genus is largely neotropical (South America and Central America) and Ethiopian (Africa).

TABLE—(*Continued*)

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3, and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
10. *Speculitermes cyclops rongrensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The species *S. cyclops* Wasmann and its various subspecies (*vide* Roonwal & Sen-Sarma 1960, pp. 16-26) are entirely Indo-Malayan (all-India ; Ceylon ; and Burma)
11. *Synhamitermes quardriceps* (Wasmann)	+	+ (Maharashtra)	+ (Rajasthan)	—	—	—	—	—	Indo-Malayan	..
12. *Microcerotermes heimi* Wasmann	+	+ (Maharashtra, & Mysore States)	—	+	—	—	—	—	Indo-Malayan	..

13. *Pseudocapritermes tikadari* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
14. *Capritermes dunensis* Roonwal & Sen-Sarma	+	—	+ (Dehra Dun, U.P.)	—	—	—	—	—	Indo-Malayan	..
15. *Capritermes latignathus durga* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The typical subspecies, *C. latignathus latignathus* Holmgren, is from Java.
16. *Macrotermes khajuriai* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
17. *Odontotermes assamensis* Holmgren	+	—	—	—	—	—	—	—	Indo-Malayan	..
18. *Odontotermes feae* (Wasmann)	+	+ (Maharashtra State)	+ (Bengal)	—	+	—	—	—	Indo-Malayan	..
19. *Odontotermes flavomaculatus* Holmgren & Holmgren	+	—	—	—	—	—	—	—	Indo-Malayan	..
20. *Odontotermes giriensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
21. *Odontotermes horai* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
22. *Odontotermes horni* (Wasmann)	+	+ (Mysore State)	+ (U.P.; W. Bengal)	+	—	—	—	—	Indo-Malayan	..

TABLE—(*Continued*)

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3, and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
10. *Speculitermes cyclops rongrensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The species *S. cyclops* Wasmann and its various subspecies (*vide* Roonwal & Sen-Sarma 1960, pp. 16-26) are entirely Indo-Malayan (all-India ; Ceylon ; and Burma)
11. *Synhamitermes quardriceps* (Wasmann)	+	+ (Maharashtra)	+ (Rajasthan)	—	—	—	—	—	Indo-Malayan	..
12. *Microcerotermes heimi* Wasmann	+	+ (Maharashtra, & Mysore States)	—	+	—	—	—	—	Indo-Malayan	..
13. *Pseudocapritermes tikadari* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
14. *Capritermes dunensis* Roonwal & Sen-Sarma	+	—	+ (Dehra Dun, U.P.)	—	—	—	—	—	Indo-Malayan	..
15. *Capritermes latignathus durga* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	The typical subspecies, *C. latignathus latignathus* Holmgren, is from Java.
16. *Macrotermes khajuriai* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
17. *Odontotermes assamensis* Holmgren	+	—	—	—	—	—	—	—	Indo-Malayan	..
18. *Odontotermes feae* (Wasmann)	+	+ (Maharashtra State)	+ (Bengal)	—	+	—	—	—	Indo-Malayan	..
19. *Odontotermes flavomaculatus* Holmgren & Holmgren	+	—	—	—	—	—	—	—	Indo-Malayan	..
20. *Odontotermes giriensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
21. *Odontotermes horai* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
22. *Odontotermes horni* (Wasmann)	+	+ (Mysore State)	+ (U.P. ; W. Bengal)	+	—	—	—	—	Indo-Malayan	..

(TABLE—*Continued*)

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3) and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
23. *Odontotermes kapuri* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
24. *Odontotermes parvidens* Holmgren & Holmgren	+	+	+	—	—	—	—		Indo-Malayan	Widely distributed in India (Assam, W. Bengal, Punjab, Mysore), W. Pakistan (W. Punjab), and E. Pakistan (E. Bengal).
25. *Hypotermes nongpriangi* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	..
26. *Hypotermes obscuriceps* (Wasmann)	+	—	—	+	—	—	—	—	Indo-Malayan	..
27. *Hypotermes xenotermitis* (Wasmann)	+	—	+ (E. Bengal)	—	+	—	—	—	Indo-Malayan	..

28. *Microtermes anandi* Holmgren (syn. *M. obesi* Holmgren)	+	+ (widely distributed)	+	+	—	—	—	—	Indo-Malayan	..
29. *Microtermes imphalensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
30. *Microtermes umsae* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
31. *Nasutitermes cherraensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
32. *Nasutitermes garoensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
33. *Nasutitermes kali* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
34. *Nasutitermes moratus* (Silvestri)	+	—	—	—	—	—	—	—	Indo-Malayan	..

(TABLE—*Continued*)

Species	Distribution								Zoogeographical Status	Remarks
	Assam Region (Assam State, NEFA, Manipur, the Naga Hills & Tuensang Area, & Tripura)	Peninsular India (below *c.* 20°N. latitude)	Rest of India (not covered by cols. 2 & 3) and W. & E. Pakistan	Ceylon	Burma	Rest of Oriental Region	China	Elsewhere		
23. *Odontotermes kapuri* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
24. *Odontotermes parvidens* Holmgren & Holmgren	+	+	+	—	—	—	—		Indo-Malayan	Widely distributed in India (Assam, W. Bengal, Punjab, Mysore), W. Pakistan (W. Punjab), and E. Pakistan (E. Bengal).
25. *Hypotermes nongpriangi* Roonwal & Sen-Sarma	+	—	—	—	—	—	—	—	Indo-Malayan	..
26. *Hypotermes obscuriceps* (Wasmann)	+	—	—	+	—	—	—	—	Indo-Malayan	..
27. *Hypotermes xenotermitis* (Wasmann)	+	—	+ (E. Bengal)	—	+	—	—	—	Indo-Malayan	..
28. *Microtermes anandi* Holmgren (syn. *M. obesi* Holmgren)	+	+ (widely distributed)	+	+	—	—	—	—	Indo-Malayan	..
29. *Microtermes imphalensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
30. *Microtermes umsae* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
31. *Nasutitermes cherraensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
32. *Nasutitermes garoensis* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
33. *Nasutitermes kali* Roonwal & Chhotani	+	—	—	—	—	—	—	—	Indo-Malayan	..
34. *Nasutitermes moratus* (Silvestri)	+	—	—	—	—	—	—	—	Indo-Malayan	..

The Vegetation of Manori and Madh Islands in Bombay[1]

BY

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INTRODUCTION

There are several small islands around Bombay City most of which are sparsely populated. In a preliminary study, these islands were classified into (a) creek or river islands and (b) coastal islands (Pradhan, Y. D. 1957). In the former, the waters surrounding the islands are non-saline or have very low salinity during the monsoon but are decidedly saline during the post-monsoon and summer seasons. The waters around the coastal islands exhibit practically no variations in salinity or pH throughout the year, as they are surrounded by sea-water. Salinity is the principal factor influencing the distribution and zonation of mangroves around these islands (Satyanarayan, in the press).

In general, the vegetation on these islands can be distinguished into : (*a*) salt marsh, (*b*) coastal—strand, salt spray, or littoral dune, and (*c*) inland vegetation, each characterized by distinct edaphic factors, resulting in halophytic, psammophytic, and glycophytic types. A brief account of the vegetation of Madh and Manori Islands is given in this paper.

Madh Island is situated off the small village of Versova on the west coast of Salsette Island, 19 km. north of Bombay. It is approachable from the city by train up to Andheri and then by bus and boat. Recently, it has been connected with Salsette Island. There is a small fort at the southern edge of Madh Island and the sandy beach on the western side is a fine picnic resort. Manori Island is roughly triangular in outline and is situated opposite the Marve beach of Salsette Island. It is about 8 km. from Borivli station. A ferry service links up the island with Malad on the Western Railway. The inhabitants on this island are mostly fishermen.

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VEGETATION

a. *Madh Island.* There are three small villages on Madh Island, viz. Madh, Davavali, and Erangal. A small stretch of deep sea separates Madh Island from Manori. Much of the original vegetation on this irregularly-shaped island has been destroyed and the land has been brought under cultivation of rice and market crops. The centre of the island is hilly.

The mangrove vegetation is confined to Malad Creek, i.e. to the eastern and northern sides of the island. The creek had originally separated the island from Salsette. Mangroves are abundant in the creek, near the island, because the creek is not very deep due to accumulation of mud and silt. But due to biotic influences, the mangroves have assumed a stunted appearance. *Avicennia officinalis* is the dominant species of the mangroves.

Around the landing jetty, even at the high water level mark, *Avicennia* is the only mangrove tree to be seen. A ' kutcha ' road leads from the jetty, which is at the south-east corner of the island, to a temple at the southern end of the island. On the left side of the road as one proceeds towards the temple is a salt marsh land dominated by *Clerodendrum inerme*, *Aeluropus lagopoides*, and *Sporobolus helvolus*. On the right side is a shallow ditch which is flooded by tidal waters during the greater portion of the day. This area is dominated by *Fimbristylis ferruginea* and *Sporobolus glaucifolius*.

Two wells are found on either side of the road, near the temple. Near these wells, the slope of the land increases and becomes rocky and sandy. This area is free from mangroves but is dominated by halophytic vegetation such as *Sporobolus virginicus*, *S. helvolus*, *Paspalidium punctatum*, *Paspalum vaginatum*, *Fimbristylis polytrichoides*, *Lindernia ciliata*, and *Sesuvium portulacastrum*. Beyond the elevated rocky area, *Avicennia* is again seen in the creek. Two distinct zones of vegetation are present : (a) the mangrove zone of *Avicennia* and (b) an inner sandy zone of *Cyperus rotundus* which covers extensive patches. In depressions, however, *Fimbristylis ferruginea* becomes more abundant. Other species found in this area are *Lindernia ciliata*, *Chloris barbata*, *Cynodon dactylon*, *Launaea sarmentosa*, and *Sesuvium portulacastrum*. Beyond the temple is a ' pucca ' road, and in the low-lying land on either side of the road there is a dense cover of *Kyllinga triceps*, *Cyperus iria*, *Cyperus compressus*, and *Scirpus maritimus*.

The temple itself is on a small knob of hill. At the foot of the hill the road forks, in the southern direction towards a small fort and the other towards the bus terminus in the west. The roadside vegetation, towards the fort side consists chiefly of *Pogostemmon parviflorus*, *Cassia tora*, *Celosia argentea*, *Tephrosia purpurea*, *Acanthospermum hispidum*, *Euphorbia microphylla, E. hirta, Abutilon indicum, Sida acuta, Melochia corchorifolia, Urena lobata, Vernonia cinerea, Ocimum americanum, Calotropis gigantea, Sesamum indicum, Commelina benghalensis, Indigofera enneaphylla, Achyranthes aspera, Ischaemum semisagittatum, Eragrostis unioloides, Eleusine aegyptiaca*, and others. Near the fort, the dominant plant is *Hyptis suaveolens.*

Near the temple is a small pond and the vegetation around it consists chiefly of *Asteracantha longifolia, Phyla nodiflora, Euphorbia hypericifolia, Ipomoea* spp., *Ammannia baccifera*, and *Ludwigia parviflora.* In the pond, only two species were observed, viz. *Ipomoea aquatica* and *Jussiaea suffruticosa.* The hill on which the temple is situated bears a few trees and shrubs of *Mangifera indica, Ficus benghalensis, Acacia arabica, Carissa congesta*, and *Jatropha curcas.*

Proceeding from the temple westwards towards Madh village, the topography is seen to be flat. *Malachra capitata* is very common and associated with it are *Solanum xanthocarpum, Amaranthus spinosus, Alternanthera triandra, Abelmoschus manihot, Lantana camara, Pedalium murex*, and *Urena lobata*, all of which are stated to be nitrophilous plants (Bharucha 1950). Beyond the village, dense patches of *Acanthospermum hispidum* are found growing in uniform patches. On the west of the island is a fairly wide beach covered mostly by *Ipomoea pes-caprae* along with *Eragrostis ciliaris, Leucas aspera*, and *Launaea pinnatifida.* A narrow track which begins near the wells on the eastern side runs across the hill in the centre and meets the pucca bus road on the west. On the hill are found *Mangifera indica, Zizyphus mauritiana, Acacia sundra, Anacardium occidentale, Phoenix sylvestris, Annona squamosa, Ficus benghalensis, Syzygium cumini*, and *Azadirachta indica.* Shrubs of *Cayratia carnosa, Leea macrophylla, Barleria prionitis*, and *Calycopteris floribunda* are found. At the foot of the hill is a banana grove and around it are found *Gynandropsis pentaphylla, Martynia diandra, Gloriosa superba, Dioscorea bulbifera, Cayratia carnosa, Aerua lanata, Calotropis gigantea*, and *Ruellia prostrata.*

Northwards towards the jetty, along the creek, *Avicennia* extends right up to the reclaimed land. The *Avicennia* zone is followed by a zone of *Aegiceras corniculatum* and *Acanthus ilicifolius.* This zone in turn is followed by a zone of *Salvadora persica* and *Clerodendrum inerme*, which is the innermost zone of the mangrove vegetation, in this island.

In the low-lying rice fields the dominant weed is *Cressa cretica*, while on elevated ground the more common weed is *Sphaeranthus indicus.* Associated with *Cressa cretica* are *Paspalum vaginatum, Marsilea quadrifida, Ammannia baccifera, Fimbristylis polytrichoides* and *Cynodon dactylon.* The plants along with *Sphaeranthus indicus* are *Grangea maderaspatana, Sphaeranthus africanus, Cynodon dactylon, Ludwigia parviflora, Eragrostis unioloides, Desmodium triflorum*, and *Setaria glauca.*

b. *Manori Island.* Manori island has an irregular and rocky topography with a low ledge of basaltic rocks running approximately south to north. There are four small villages, all situated on the western side of the island known as Manori, Gorai, Utan and Dongri. Of these, Dongri is situated at the northern tip of the island, facing the Fort of Bassein on the mainland. Two large creeks separate Manori from Salsette. The larger of these creeks runs from Marve northwards to Mira Road and Mandapeshwar from where it takes a north-easterly course towards the mainland, joining the Bassein Creek. The mangrove vegetation occurs only along the creeks on the eastern side but not on the western side of Manori island. This is due to the fact that the western shore is quite sandy and is subject to direct and powerful tidal action from the Arabian Sea.

The chief mangrove species is *Avicennia officinalis* which makes its appearance on the coast between Manori village and Marve on Salsette. *Avicennia* is particularly abundant in the mid-littoral zone near the jetty at Manori village and extends all along the creek right up to Mandapeshwar. Off Mira Road, occasional plants of *Ceriops candolleana* are found, while *Acanthus ilicifolius* is abundant in the supra-littoral fringe. In the most sheltered areas of Manori Creek, *Salvadora persica* is seen with *Suaeda fruticosa* and *Aeluropus lagopoides* in the supra-littoral zone.

At the junction of Manori Creek with Bassein Creek, where the waters are deeper, *Rhizophora mucronata* is seen growing amidst *Avicennia*, right up to Bassein Bridge. At the outskirts of Bassein Fort, on the mainland, the beaches are regularly bathed by tides and dense patches of *Arthrocnemum glaucum* occur, occasionally interspersed with *Aeluropus lagopoides*.

Near the jetty at Manori, and extending almost up to Manori village are *Clerodendrum inerme* and *Cyperus rotundus*. A ‘ kutcha ’ road runs almost parallel to this halophytic zone. On the left hand side of the road, as one proceeds towards the village, the ground is dominated entirely by *Acanthospermum hispidum*, *Indigofera cordifolia*, and *Desmodium triflorum*. As the road curves westwards, small sand hummocks are seen, bearing *Sporobolus virginicus*, *Paspalidium punctatum*, *Cynodon dactylon*, and *Fimbristylis polythricoides*. *Arthrocnemum indicum* and *Salicornia brachiata* are dominant on the strand. On the western side of the island, the kutcha road passes over a small lagoon, on the banks of which *Aeluropus lagopoides* and *Suaeda fruticosa* are found. Along the left side of the road are rice fields.

In the crevices of the rocky cliffs only two species are found, viz. *Lindenbergia urticaefolia* and *Apluda mutica*. Rarely, a few plants of *Ischaemum rugosum* are also found. The rocks were found to contain 10 to 15 per cent. calcium carbonate.

Further inland, *Acanthospermum* is replaced by a community of *Cassia tora.* Other nitrophilous plants are *Solanum xanthocarpum* and *Xanthium strumarium.* On the northern side of the island are grazing lands in a deteriorated condition. The kutcha road ends near Manori village, around which are many rice fields. Dominant weeds in the rice fields are *Cressa cretica* associated with *Sida veronicaefolia, Lindernia ciliata, Cyanotis axillaris, Eleusine indica, Ammannia baccifera, Blepharis molluginifolia, Vernonia cinerea, Blumea eriantha, Panicum psilopodium, Eclipta prostrata,* and *Euphorbia hirta.* From the floristic composition, it is clear that these weeds are generally characteristic of saline conditions.

As mentioned earlier, the western aspect of the island is devoid of mangroves but on the sandy beaches *Spinifex littoreus* is dominant together with *Eragrostis ciliaris* generally in areas where the rock outcrop is covered with a thin mantle of soil. But, where the soil mantle is deep, *Ipomoea pes-caprae* dominates along with *Borreria hispida, Launaea sarmentosa,* and *Phyla nodiflora.* Further north, the carpet vegetation is replaced by a tall, luxuriant zone of *Pandanus tectorius.* Behind the *Pandanus* zone is a large coconut grove and the common species in the grove are *Indigofera cordifolia* and *Desmodium triflorum.*

If one proceeds towards the left of the jetty, *Acanthospermum hispidum* is seen to be the dominant plant. The sandy beaches are dominated by *Cyperus rotundus* along with *Spinifex littoreus.* Beyond the *Acanthospermum* zone is a fairly extensive grazing land but covered mostly by over-grazed species like *Eragrostis unioloides.* Other species found in these grazing lands are *Curculigo orchioides, Commelina nudiflora, Phyllanthus niruri, Euphorbia hirta, Melothria maderaspatana, Rhamphicarpa longifolia, Evolvulus alsinoides, Lindernia ciliata, Indigofera cordifolia,* and *Urginea indica,* all of which are seasonal species of the monsoon. At places where over-grazing is not severe, the grazing lands are dominated by taller species like *Heteropogon contortus, Paspalidium flavidum, Ischaemum ciliare,* and *Ischaemum rugosum.* Bushes of *Holarrhena antidysenterica* and *Calycopteris floribunda* are also commonly seen further inland.

Occasionally, *Celosia argentea* is found in small patches beyond the grazing lands as one approaches the rice fields. The dominant weed of the rice fields is *Cressa cretica* and associated species are *Sida veronicaefolia, Lindernia ciliata, Caesulia axillaris, Eleusine indica, Ammannia baccifera, Blepharis molluginifolia, Vernonia cinerea, Blumea eriantha, Panicum psilopodium, Eclipta prostrata,* and *Euphorbia hirta.*

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Copepods parasitic on South Indian Fishes: Family Bomolochidae—3

BY

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(With eight text-figures)

[*Continued from Vol.* **61** (1) : 59]

The present paper describes eight species of *Bomolochus*, four of which are new. In a previous publication (Pillai 1962) I described a new species, *B. aculeatus*, closely resembling *B. leptoscari* Yamaguti (1953) and *Orbitacolax uniunguis* Shen (1957), and also expressed the opinion that *Orbitacolax* cannot be considered as distinct from *Bomolochus*. While describing *B. aculeatus* Pillai, I overlooked its close similarity to *Taeniacanthus hapalogenyos* Yamaguti & Yamasu (1959). The position of the maxilliped with respect to the other mouth parts easily distinguishes bomolochids from taeniacanthids. Yet an experienced worker like Yamaguti erred in placing the above-mentioned species under Taeniacanthidae. It is likely that *B. aculeatus* is the same as *B. hapalogenyos* (Yamaguti & Yamasu).

Wilson (1911), Yamaguti (1939), and Shen (1957) attempted a division of *Bomolochus* into genera or subgenera. As shown by Stock (1953) this division is quite unnatural and the above-mentioned authors themselves contradicted their own observations. In the present study this division is not followed.

Wilson (1911) observed that in Bomolochidae the male is free-living and that mating takes place before the female seeks out a host. Gnanamuthu (1947) and Stock (1953) showed that this is not so. During the course of the present investigation I have been able to collect the males of three species of *Bomolochus* in good numbers and some of them were actually observed in copulation. It is true that the males of a vast majority of species are unknown, but this is not because they are free-living. The male is invariably small and nearly transparent and hence easily overlooked. Flushing the opercular chamber with water and examining the residue under a binocular microscope was always found highly rewarding.

During the present investigation the detailed structure of the spines arming legs two to four has been found to constitute a very useful diagnostic character. The second antenna of *Bomolochus* has often been described as two-, three-, or even four-segmented. In all the species I have been able to examine this appendage is three-segmented. What is described as the fourth segment is a linguiform prolongation of the third segment. Similarly the fifth leg has been occasionally described as three-segmented, but it consists of only two segments.

Bomolochids are extremely common but only four species, *B. megaceros* Heller (1865), *B. triceros* Bassett-Smith (1898a), *B. multispinosus* Gnanamuthu (1947), and *B. acutus* Gnanamuthu (1948) have so far been described from this region.

Genus **Bomolochus** Nordmann

Bomolochus triceros Bassett-Smith

Bomolochus triceros Bassett-Smith, 1898a, p. 2, pl. 1, f. 1. ? *Bomolochus managatuwo* Yamaguti, 1939, pl. 3, figs. 28-29, pl. 4. figs. 30-37.

Text-fig. 15.

Material. 3 females were collected by the author from the inner surface of the opercle of *Pampus argenteus* (Euphrasen) at Trivandrum.

Female. Carapace much broader than long, its antero-median part deeply incised, and posterior border nearly straight. Second thoracic segment posteriorly concave, third segment narrower than second and overlapping the fourth segment, latter short, less than half as broad as third segment, fifth segment very small. Genital segment broader than long, subequal to the first abdominal segment. Abdomen long and four-segmented. Anal laminae longer than broad, with a long distal seta and three smaller setae.

First antenna indistinctly seven-segmented, first four segments stout and partially fused, last three segments slender, second segment with a short but broad process carrying three stout but subequal spines, middle spine chitinised and blunt, others rugose and apically drawn out, second and third segments carrying five modified setae, first seta very long and placed close to the spines. Distal segment of second antenna with well-spaced tubercles and produced into a linguiform process, its distal border with seven claws and a toothed blunt process.

Mandibular blades subsimilar, spiny along the lower border. First maxilla with four plumose setae, two of them large. Blades of second maxilla long and pointed, with barbed edges. Maxilliped with very long claw and three pectinate setae, claw without accessory process.

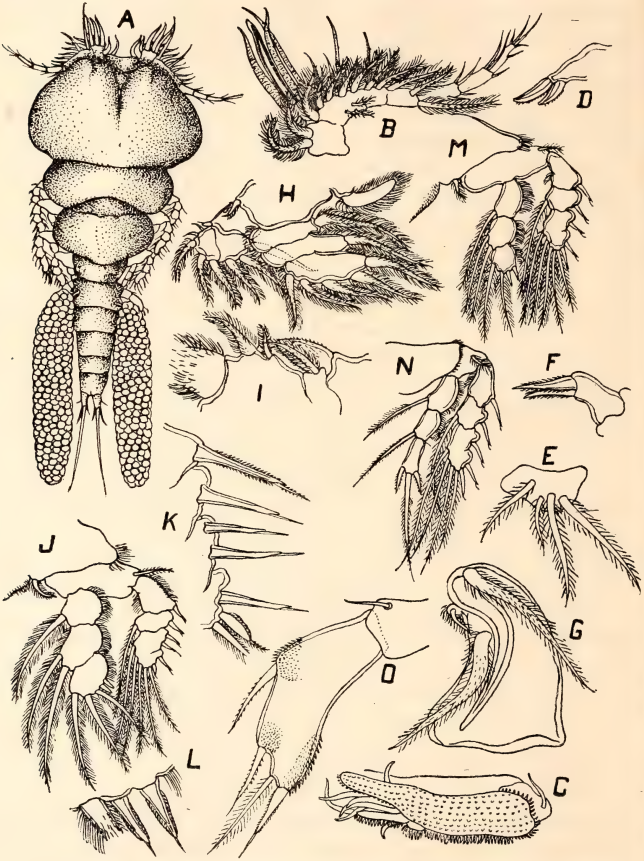

Fig. 15. *Bomolochus triceros* Bassett-Smith. Female: A. dorsal view; B. antenna 1; C. antenna 2; D. mandible; E. maxilla 1; F. maxilla 2; G. maxilliped; H. leg 1; I. same, exopod; J. leg 2; K. same, exopod; L. same, tip of endopod; M. leg 3; N. leg 4; O. leg 5

First leg with three-segmented rami. Exopod of second leg with five strong, barbed spines, each with a trigger-like apical spinule, sixth spine broad and blunt, with an outer flange and pectinate subapical spinule, endopod only slightly broader than exopod, distal segment with two identical short spines, with thin flange and an apical spinule. Exopod of third leg slightly broader than endopod, with five similar spines. Endopod of fourth leg very slender, first two segments with an outer long pectinate seta, third segment with one very long and two short pectinate spines. Distal segment of fifth leg with four spines and three groups of spinules. Egg sacs cylindrical, reaching the tip of the caudal setae.

Total length 2.2 mm.

Remarks. There are certain minor mistakes in the description of this species by Bassett-Smith. He described the second antenna as two-segmented, but it is, as usual, three-segmented and the distal segment carries seven and not four claws. The maxilliped has three setae, and not one as stated by Bassett-Smith. The rami of the first leg are three- and not two-segmented.

Bomolochus (*Pseudobomolochus*) *managatuwo Yamaguti* (1939) is so much like the present species even in minute details that I am almost sure that they are identical. Both are parasites of *Pampus argenteus*.

Bomolochus denticulatus Bassett-Smith

Bomolochus denticulatus Bassett-Smith, 1898b, p. 77, pl. 3, f. 1.

Text-fig. 16.

Material. 28 females and 3 males were collected by the author from the inner surface of the opercle of *Sphyraena jello* Cuvier at Trivandrum.

Female. Carapace nearly semicircular, second thoracic segment only slightly narrower than carapace, its hind border slightly concave, third segment roughly equal in length and breadth, completely overlapping the fourth segment, fifth segment much broader than long, partially covered by the third segment. Genital segment slightly narrower than fifth segment. Abdomen three-segmented, anal laminae with one long and four short setae.

Basal segments of first antenna completely fused, with a large process carrying three comparatively short processes, middle process longer and chitinised, others pointed and rugose, modified setae four, one of them very short. Distal segment of second antenna sparsely spiny, with six claws and a toothed process. Mandible and second maxillae as usual in the genus, first maxilla with three setae, its inner process hairy. Claw of maxilliped without accessory process, a minute knob is occasionally present.

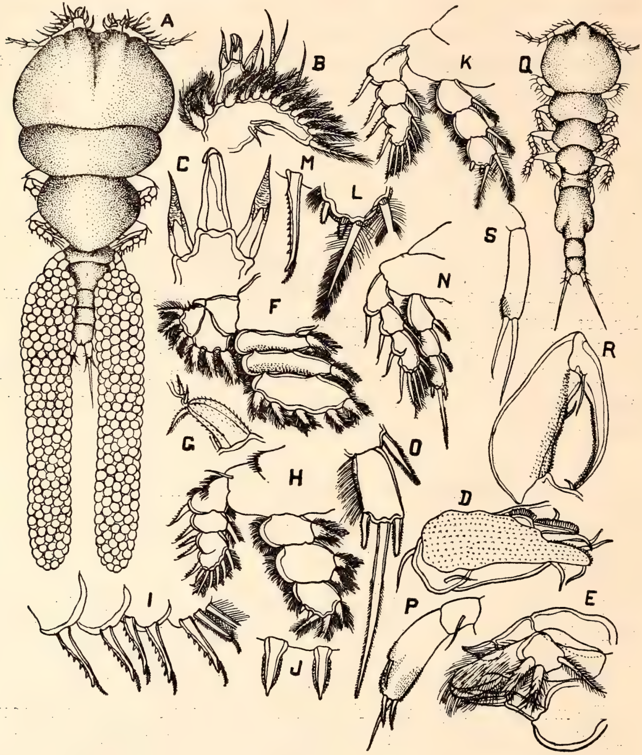

Fig. 16. *Bomolochus denticulatus* Bassett-Smith. A-P. Female : A. dorsal view ; B. antenna 1 ; C. same, spinous processes ; D. antenna 2 ; E. mandible and maxillae ; F. leg 1 ; G. exopod ; H. leg 2 ; I. exopod ; J. tip of endopod ; K. leg 3 ; L. tip of endopod ; M. spine on exopod ; N. leg 4 ; O. tip of endopod ; P. leg 5. Q-S. Male : Q. dorsal view ; R. maxilliped ; S. leg 5

Rami of first leg very much flattened, three-segmented, first two endopod segments pustulose. Endopod of second leg flattened, third segment with two stout but short-winged spines, exopod with six spines, first five with five to six teeth on the outer border and a pectinate apical spinule, sixth spine apically blunt and externally pectinate. Third leg with subsimilar rami, spines on third endopod segment barbed, exopod similar to that of second leg. Endopod of fourth leg slender, with two short outer pectinate spines, third segment with two short and one very long pectinate spines. Fifth leg comparatively narrow, distal segment with three pectinate spines and a long spine seta. Egg sacs stout and cylindrical, as long as the body.

Total length 2.6 mm.

Male. Body slender, carapace nearly circular, with very prominent rostral process. Thoracic segments two to four steadily decreasing in length and breadth, fifth segment short, completely free. Genital segment pyriform and large, abdomen three-segmented, with parallel sides. Second and third segments of maxilliped with tuberculate inner border, each with a spine seta. Fifth leg slender, distal segment with long spines and a patch of spinules.

Total length 1.3 mm.

Remarks. As observed by Bassett-Smith this species can be easily distinguished by the shape of the prominent frontal processes on the first antenna, denticulated claws of the legs and the extremely enlarged third segment of the trunk. Bassett-Smith described the processes on the first antennae as very short, obtuse-ended bristles of about equal length. But the middle spine alone is obtuse-ended, the others are apically drawn out as usual. Generally these processes remain bent and their true shape will be visible only if examined under a cover glass.

Bomolochus megaceros Heller

Bomolochus megaceros Heller, 1865, p. 153, pl. 13, f. 2.

Text-fig. 17

Material. Several females and males were collected by the author from the gills and inner surface of the opercle of *Parastromateus niger* (Bloch) at Trivandrum.

Female. Carapace nearly twice as broad as long, frontal incision shallow and broad. Second thoracic segment slightly narrower than carapace, third segment as long as second but narrower, fourth segment transversely ovate and as long as third segment. Fifth segment transversely rectangular, slightly narrower than fourth.

Genital segment longer and broader than fifth, abdomen short, three-segmented. Anal laminae with two long distal setae and three or four smaller ones.

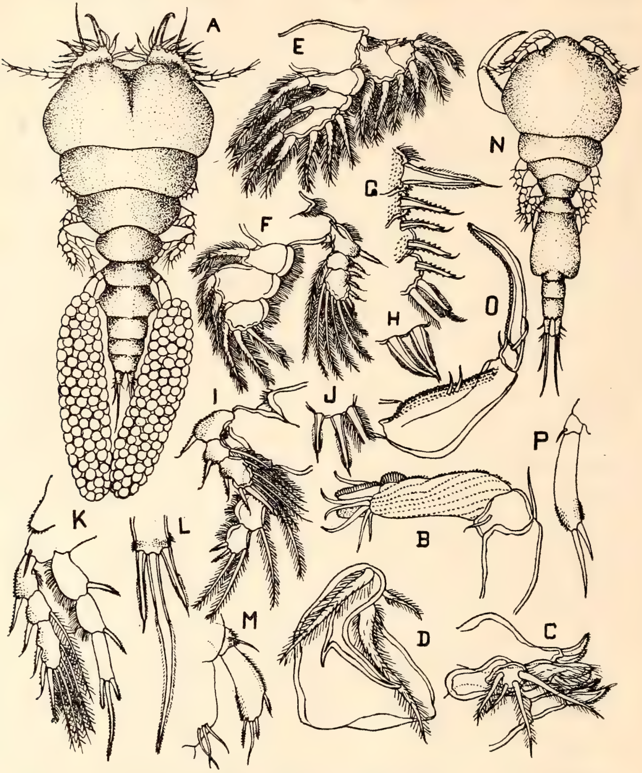

Fig. 17. *Bomolochus megaceros* Heller. A-M. Female : A. dorsal view ; B. antenna 2 ; C. mandible and maxillae ; D. maxilliped ; E. leg 1 ; F. leg 2 ; G. exopod ; H. tip of endopod ; I. leg 3 ; J. tip of endopod ; K. leg 4 ; L. tip of endopod ; M. legs 5 and 6 ; N-P. Male : N. dorsal view ; O. maxilliped ; P. leg 5

First antenna with a prominent strongly curved chitinised process and a long and a short modified seta. Third segment of second antenna with longitudinal rows of spines, distal border with six claws and a blunt spiny process. Blades of mandible rather long and spiny. First maxilla with four setae, one of them very small, inner process hairy. Second maxilla with broad barbed blades. Claws of maxilliped strongly curved, with a prominent sharp accessory process.

Exopod of first leg as broad as endopod and two-segmented. Exopod of second leg pustulose, first spine winged, second to fifth toothed on both sides, sixth winged on one side, all the spines with a subapical spinule, endopod very broad, third segment with two winged triggered spines. Exopod of third leg pustulose, spines barbed only on one side, third segment of endopod with two long pectinate spines. Exopod of fourth leg similar to that of third, endopod slender, with two pectinate outer spines and three distal spines, median distal spine very long. Fifth leg with a long simple spine seta and three pectinate spines on second segment. Sixth leg formed of three setae. Egg sacs large, with large eggs.

Total length 2.9 mm.

Male. Carapace nearly equal in length and breadth, with a short but broad rostrum. Trunk segments regularly narrowing, fifth segment broader than fourth. Genital segment longer than broad, broader behind. Abdomen three-segmented. Distal segment of fifth leg long and slender, with two short spines. Inner part of second segment of maxilliped with several rows of pustules, inner border of distal segment with a closely packed row of tubercles.

Total length 1.3 mm.

Remarks. Heller's figure of the entire animal is far from correct and in the illustrations of the appendages he has omitted practically all details. Nevertheless the identity of the present material is very clear.

Bomolochus multispinosus Gnanamuthu

Bomolochus multispinosa Gnanamuthu, 1947, p. 309, figs. 1-5.

Text-fig. 18

Material. 3 females were collected by the author from the inner surface of the opercle of *Dussumieria hasselti* Bleeker at Trivandrum.

Female. Carapace nearly one and a half times as broad as long, slightly concave posteriorly, frontal sinus deep. Second thoracic segment transversely rectangular, third transversely ovate and partially overlapping the fourth segment, latter very narrow, fifth segment still narrower. Genital segment broader than fifth segment. Abdomen three-segmented, narrowing backwards. Anal laminae 2½ times as long as broad, with a very long distal seta.

First antenna with a stout basal part carrying three large chitinised processes, middle process slightly longer than the others, modified setae four, first placed close to the third process. Distal segment of second antenna sparsely spiny, with a spinous process, four claws, and two spine setae. Mandible with two smooth blades, lower blade smaller. First maxilla with one small and three large setae Second maxilla with a slender spine and two long barbed blades. Claw of maxilliped moderately curved, without accessory process.

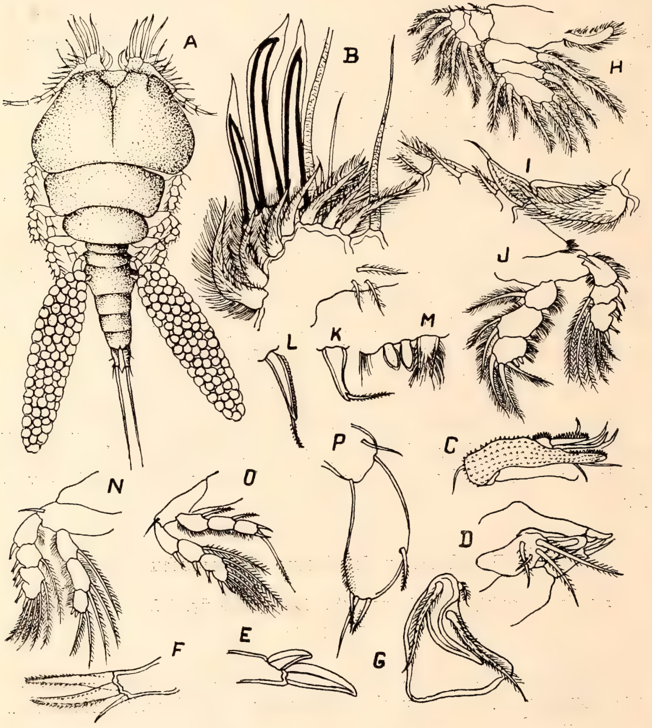

Fig. 18. *Bomolochus multispinosus* Gnanamuthu. Female: A. dorsal view; B. antenna 1; C. antenna 2; D. mandible and maxillae; E. mandible; F. maxilla 2; G. maxilliped; H. leg 1; I. exopod; J. leg 2; K-L. spines on exopod; M. tip of endopod; N. leg 3; O. leg 4; P. leg 5

Rami of first leg three-segmented, exopod nearly as broad as endopod. Exopod of second leg with six spines, first five with forked tip carrying a spinule, last spine with a frilled external flange, endopod only very slightly broader than exopod, its distal segment with two blunt ovate spines with thin border. Third leg smaller than second. Fourth leg smaller than third, rami very slender, endopod with two outer pectinate spines and three distal spines, middle distal spine very long. Distal segment of fifth leg with a long spine seta and three pectinate spines.

Total length 2.3 mm.

Remarks. As Gnanamuthu has given only simple illustrations the more obvious differences alone could be pointed out. The first maxilla has four setae and the second maxilla a slender spine in addition to the two blades. The maxilliped carries three instead of two setae. The terminal segment of the endopod of the first leg carries five and not six setae. Gnanamuthu described legs two to four as similar, but they show clear differences in size as well as in armature. He has described the exopods of the legs as four-segmented, but the strong constriction on the distal segment does not appear to indicate a fourth segment.

B. multispinosus has the closest resemblance to *B. triceros* Bassett-Smith but in the latter only the middle process of the first antenna is chitinised. In the structure of the spines on the legs also they differ.

Bomolochus selaroides sp. nov.

Text-fig. 19

Material. 5 females were collected by the author from the inner surface of the opercle of *Selaroides leptolepis* (Cuvier) at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C4613/1).

Female. Carapace broader than long, with a broad prominent frontal incision and a pair of shallow lateral ones. Second trunk segment narrower than carapace, its hind border concave. Third segment transversely ovate, as long as second but narrower, fourth segment transversely oblong, fifth segment very small. Genital segment large, twice as long as fifth segment but much broader. Abdomen very short, three-segmented. Anal laminae slightly longer than broad. Egg sacs long and elliptical.

First antenna six-segmented, first three segments stout and partially fused, with a strong apically recurved chitinised process, fourteen stout plumose setae and three modified setae, middle modified seta very long. Distal segment of second antenna with longitudinal rows of spines, margin with long closely packed blunt teeth, distal border with a blunt toothed process and a bunch of five claws. Mandible with two blades, upper blade large, curved, and spiny, lower much smaller. First maxilla with four plumose setae, second maxilla with two unequal barbed blades. Claw of maxilliped with a prominent, curved, and acute accessory process.

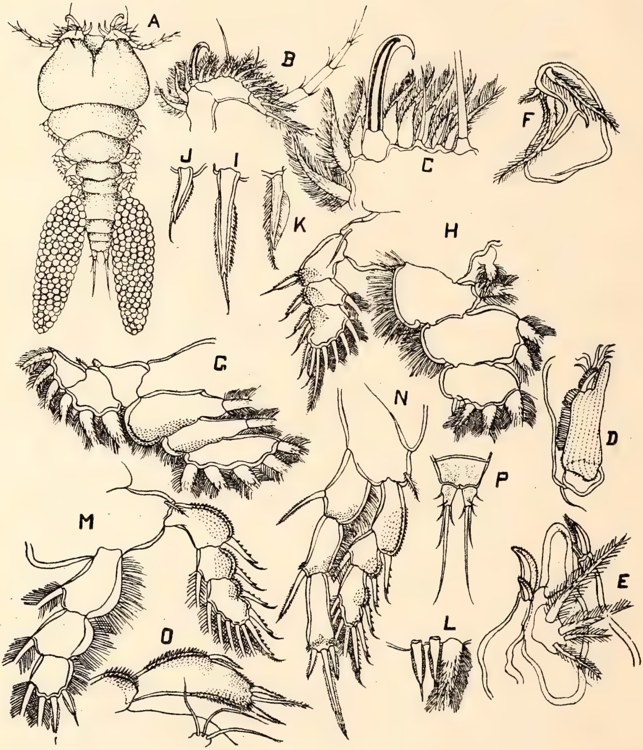

Fig. 19. *Bomolochus selaroides* sp. nov. Female: A. dorsal view; B. antenna 1; C. base enlarged; D. antenna 2; E. mandible and maxillae; F. maxilliped; G. leg 1; H. leg 2; I-K. spines on exopod; L. tip of endopod; M. leg 3; N. leg 4; O. legs 5 and 6; P. tip of abdomen

First leg highly flattened, with three-segmented rami, first two endopod segments pustulose. Exopod of second leg pustulose, first spine winged, next four not winged, last externally winged, all the spines with a subapical pectinate spinule; endopod very broad, with two short winged spines, each with an apical spinule. Third leg with prominently pustulose exopod, spines externally toothed and with a subapical spinule, endopod only slightly broader than exopod, spines on third segment longer than those on second leg. Fourth leg with comparatively slender rami, both pustulose, exopod spines similar to those of third leg, endopod with two outer pectinate spines and three distal winged spines, middle distal spine moderately long. Fifth leg prominently spiny, with three pectinate spine setae and a slender plumose seta. Sixth leg formed of three simple setae.

Total length 2.1 mm.

Remarks. *B. selaroides* closely resembles *B. decapteri* Yamaguti (1936) even in details. The shape and the armature of the legs are almost identical, but in *B. decapteri* the body is more robust and comparatively short and the egg sacs almost oblong.

Bomolochus hemirhamphi sp. nov.

Text-fig. 20

Material. 20 females were collected by the author from the inner surface of the opercle of *Hemirhamphus marginatus* Forskal at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C4614/1).

Female. Body short but stout. Carapace semicircular, with shallow median and indistinct lateral grooves. Second trunk segment immersed in carapace, laterally rounded and posteriorly concave. Third segment transversely oblong, immersed in second segment, fourth segment fairly large, overlapping fifth segment, fifth segment as broad as genital segment. Abdomen short, three-segmented. Egg sacs oblong and short.

First antenna six-segmented, first three segments stout, with fourteen large plumose setae, a stout curved sickle-shaped spine, and three modified setae. Distal segment of second antenna with longitudinal rows of spines, margin with a row of closely packed teeth, distal border with a spiny process and six claws. Mandible with broad blades, lower blade much smaller. First maxilla with four setae. Second maxilla with a small spine and two long strongly barbed blades. Claw of maxilliped with prominent accessory process.

First leg with moderately flattened three-segmented rami. Exopod of second leg with six spines, each spine with outer wing and subapical spinule, endopod broad, with two short blunt spines. Third leg with subsimilar rami, exopod very slightly broader, with five spines, very much similar to those on second leg except that the first spine is winged on both sides and the fifth is much longer. Exopod of fourth leg

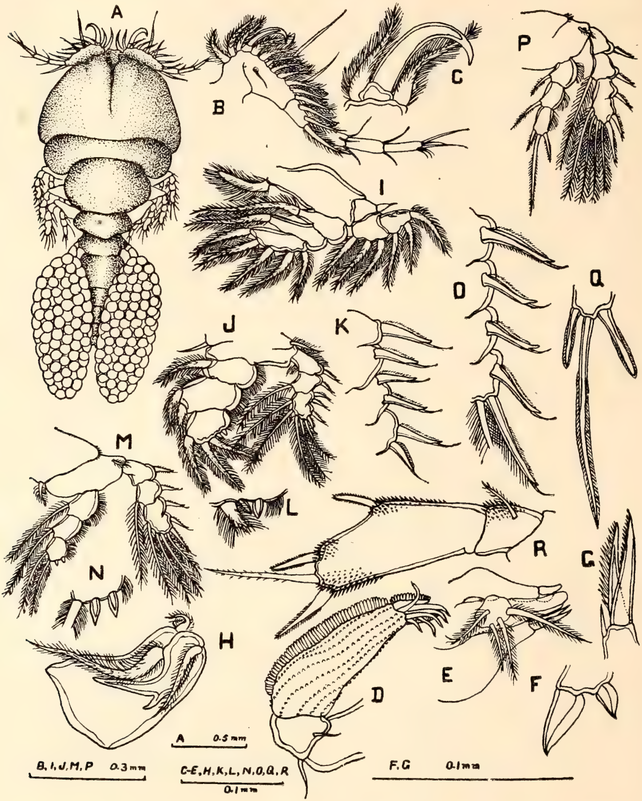

Fig. 20. *Bomolochus hemirhamphi* sp. nov. Female: A. dorsal view; B. antenna 1; C. chitinous process; D. antenna 2; E. mandible and maxillae; F. mandible; G. maxilla 2; H. maxilliped; I. leg 1; J. leg 2; K. exopod; L. tip of endopod; M. leg 3; N. tip of endopod; O. exopod; P. leg 4; Q. tip of endopod; R. leg 5

exactly like that of third, endopod slender, with two pectinate outer spine setae and three distal winged spines, median distal spine very long. Distal segment of fifth leg with three strong, pectinate spines, each with a patch of spinules at its base and a long sparsely pectinate spine, basal segment with a seta and a patch of spinules.

Total length 1.8 mm.

Remarks. In the general shape of the body and the structure of the appendages *B. hemirhamphi* closely resembles *B. decapteri* Yamaguti (1936). They agree in the presence of a single spine on the first antenna, shape of the legs, especially of the first, second, and fifth pairs, and also in the shape of the egg sacs. But in *B. decapteri* the spines on the legs two to four are denticulated and the exopod segments are pustulose. In *B. hemirhamphi* the spines are winged and the exopod segments are not pustulose. *B. hemirhamphi* also resembles *B. hyporamphi* Yamaguti & Yamasu (1959), but in the latter the egg sacs are elliptical and Yamaguti & Yamasu make no mention of the armature of the spines on the legs. *B. hemirhamphi* has a spinule in addition to the two blades on the second maxilla; according to Yamaguti & Yamasu this spine is not present in *B. hyporamphi*. The present species also resembles *B. tumidus* Shiino (1957) to some extent.

Bomolochus kanagurta sp. nov.

Text-fig. 21

Material. 18 females and 6 males were collected by the author from the inner surface of the opercle of *Rastrelliger kanagurta* Cuvier at Trivandrum. Holotype, female, and allotype, male, are deposited in the Indian Museum, Calcutta (Reg. Nos. C4616/1 and C4617/1).

Female. Body stout and tumid. Carapace with a broad shallow frontal incision and a pair of lateral grooves, its posterior border nearly straight. Second trunk segment narrow, its hind border concave. Third segment transversely ovate, longer than second and almost completely hiding the fourth segment in dorsal view, fourth segment overlapping fifth, fifth segment short, slightly broader than first abdominal segment. Abdomen four-segmented, steadily narrowing backwards. Anal laminae twice as long as broad, with a long stout apical seta. Egg sacs as long as body in front of fourth segment, narrowing backwards, eggs large and rounded.

First antenna with a bunch of three spines borne on a chitinous base and three modified setae successively decreasing in length, middle spine shorter than the lateral ones and chitinised. Distal segment of second antenna with longitudinal rows of denticles, distal border with a spiny process and six claws. Mandible with two curved subsimilar blades. First maxilla with four setae, two of them large, inner process spiny and hairy. Distal segment of second maxilla short, with a large spiny spatulate blade, a narrow strongly barbed spine, and a simple third spine. Second segment of maxilliped comparatively broad, claw short, with a small blunt accessory process.

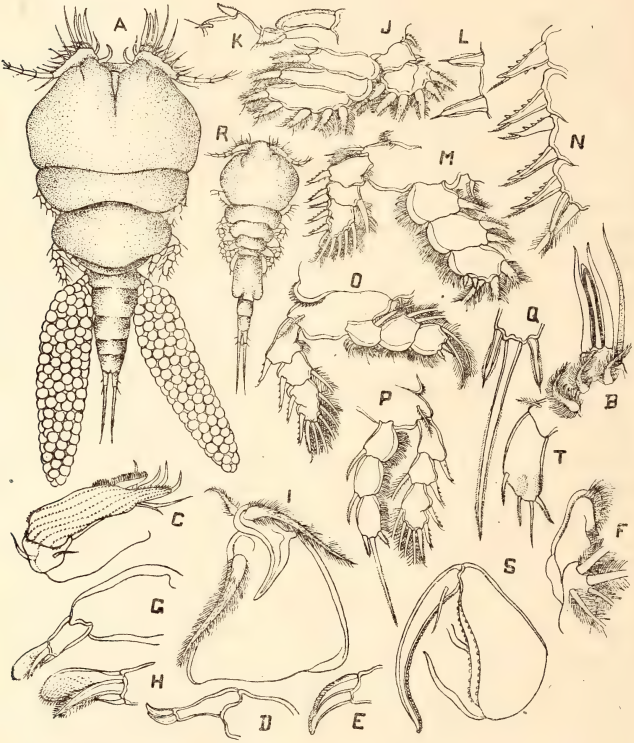

Fig. 21. *Bomolochus kanagurta* sp. nov. A-Q. Female: A. dorsal view; B. antenna 1, base; C. antenna 2; D. mandible; E. mandible, blades enlarged; F. maxilla 1; G. maxilla 2; H. blades enlarged; I. maxilliped; J. leg 1; K. exopod; L. tip of endopod, leg 2; M. leg 2; N. exopod; O. leg 3; P. leg 4; Q. endopod. R-T. Male: R. dorsal view; S. maxilliped; T. leg 5

First leg with three-segmented rami. Endopod of second leg broad, third segment with two short winged spines, each carrying an apical spinule, exopod with six spines, first spine toothed on both sides, second to fifth only on the outer side, and sixth without teeth, each spine with a pectinate apical seta. Endopod of third leg very slightly broader than exopod, exopod with five spines, last spine pectinate externally. Rami of fourth leg of equal breadth, spines on exopod similar to those on third leg, endopod with two outer pectinate spines and three pectinate distal spines, median distal spine moderately long. Fifth leg of uniform width, second segment with three pectinate spines and a simple seta.

Total length 2.5 mm.

Male. Carapace broader than long, with very prominent rostrum, trunk segments steadily narrowing backwards, genital segment large, abdomen three-segmented, slightly narrowing backwards. Second segment of maxilliped with two rows of tubercles, third segment with a spine and a marginal row of tubercles.

Total length 1.4 mm.

Remarks. In the shape of the processes of the first antenna *B. kanagurta* resembles *B. triceros* Heller, but in the latter the nature of the third and fourth trunk segments and the spinulation of the legs are different. In the over-all shape of the body and the structure of the legs *B. kanagurta* also resembles *B. denticulatus* Bassett-Smith, but the structure of the processes on the first antenna easily distinguishes them. The denticulate and hairy inner process of the first maxilla and the spatulate blade of the second maxilla are very characteristic of *B. kanagurta.*

Bomolochus monoceros sp. nov.

Text-fig. 22

Material. 7 females were collected from the inner surface of the opercle of *Carangoides malabaricus* (Bloch) by the author at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C4615/1).

Female. Carapace roughly semicircular, with nearly straight hind border, antero-median groove fairly deep. Trunk segments steadily narrowing backwards. Genital segment enlarged, much longer than adjacent segments. Abdomen short, three-segmented. Anal laminae short. Egg sacs long, slender, and cylindrical, nearly as long as the body.

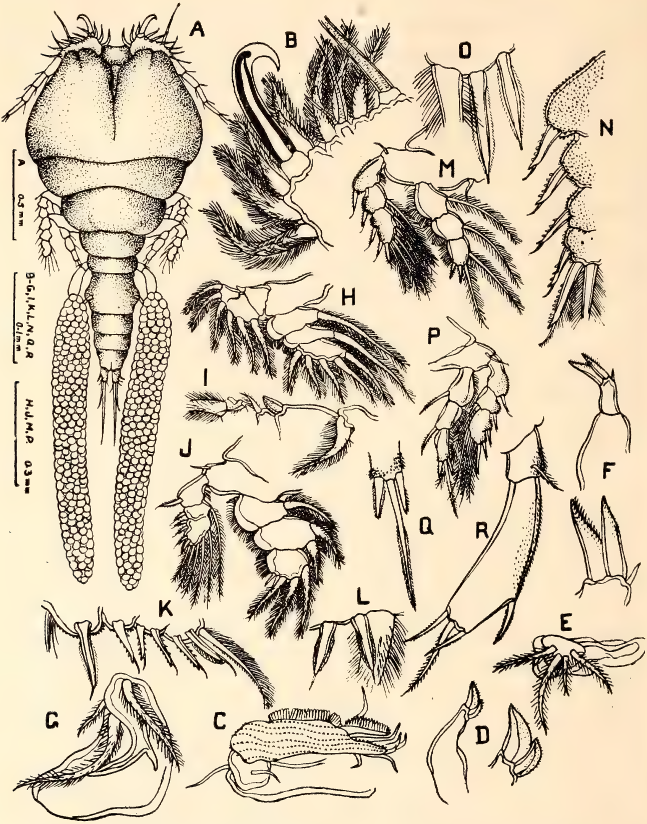

Fig. 22. *Bomolochus monoceros* sp. nov. Female: A. dorsal view; B. antenna 1; C. antenna 2; D. mandible; E. maxilla 1; F. maxilla 2; G. maxilliped; H. leg 1; I. exopod; J. leg 2; K. exopod; L. tip of endopod; M. leg 3; N. exopod; O. tip of endopod; P. leg 4; Q. endopod; R. leg 5

Basal part of first antenna with a single large chitinised, apically curved spine. Distal segment of second antenna with longitudinal rows of denticles, distal border with a bunch of seven comparatively weak claws. Mandible with broad spiny blades, lower blade smaller. First maxilla with four setae. Second maxilla with a small spine and two subsimilar spiny blades. Claw of maxilliped with well-developed accessory process.

First leg with three-segmented rami. Endopod of second leg broad, with two winged spines, each carrying a spinule, exopod with six spines, first spine winged on both sides, last winged externally, others toothed on both sides, each spine with a subapical spinule. Endopod of third leg only slightly broader than exopod, latter with the surface pustulose and carrying five spines toothed externally, fifth spine comparatively large. Exopod of fourth leg similar to that of third, endopod with two outer pectinate spines and three distal spines, third segment distally spiny. Basal segment of fifth leg with a patch of spinules and a plumose seta, distal segment comparatively long and externally spiny, with three pectinate spines and a long spine seta.

Total length 1.9 mm.

Remarks. In the structure of the legs, particularly the spinulation of the exopods, this species resembles *B. decapteri* Yamaguti (1936) but in the latter the third trunk segment overlaps the fourth considerably and the egg sacs are oblong.

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The Exotic Flora of Kodaikanal

BY

K. M. MATTHEW, S.J.

For over a century, Kodaikanal (2000-2300 m.) with its quasi-temperate climate has been a favourite hill station in south India. A number of European officials of the British Indian Government and missionaries spent their summer months there or made it their home after retirement from service. It is known that many of these people have introduced various plants at Kodaikanal from semi-tropical or temperate regions of the world. Over the years, these plants became so well naturalized and spread that at present some of the exotic species are among the more prominent members of the vegetation.

To a student of botany in India, such species are very interesting on the one hand, but on the other they offer great difficulties with their correct identification. J. S. Gamble and P. F. Fyson, who wrote on the Flora of Madras, mention together just over 100 species of introduced plants at Kodaikanal, but this hardly helps in the identification of these plants, much less in a complete knowledge of the species. Besides, these two authors have left unmentioned a far greater number of species. Botanists visiting the place were often unable to identify the plants or, still worse, gave wrong names to them. Besides the problem of their correct identity, their ecology in the new habitat had to be studied against similar data from their native countries. More recently, numerous queries used to be made regarding the possibility of commercial exploitation of some of the economically important plants like wattles, eucalyptus, fruit trees, and grasses. Thus the need for an exhaustive study of the exotic flora was pressing, which the present author made during 1960-1962 (in addition to his previous explorations during 1950-1960), the results of which have been incorporated in a thesis accepted by the University of Bombay towards the degree of PH.D.

The work is a taxonomic study of what may be called the *permanent exotic flora* of Kodaikanal, consisting of the woody plants and naturalized herbs, leaving out the exotic herbs of the vegetable and flower gardens, which are more or less transient. The term *exotic* connotes introduced plants from outside peninsular India.

A word about the identification of the plants. After checking the plants at five Indian herbaria, including the Central National Herbarium, Calcutta, the identity of a number of plants still remained doubtful. Hence the following experts from outside India were consulted: H. Gaussen, Directeur du Laboratoire Forestier, Toulouse, (Gymnosperms); S. T. Blake, Botanic Gardens, Brisbane, (Eucalyptus); the Superintendent, Royal Botanic Gardens, Peradeniya, (Palms); and the Director, Royal Botanic Gardens, Kew.

Pending the publication of the work in book form, a complete enumeration of the species studied is published here. 344 species from 223 genera belonging to 82 families are enumerated. Families are arranged as in Bentham & Hooker: GENERA PLANTARUM (1862-1883), except for placing the Gymnosperms at the beginning, and for following Hutchinson's FAMILIES OF FLOWERING PLANTS (1959) in the splitting up of certain families into more uniform groups. Within each family, genera and species are given in alphabetical order.

Besides making available a full list of names of the large number of exotic species growing in the area, the present paper gives the correct name of each plant according to the norms of the INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (ed. 1961) with the full reference to the original publication of the name. The basionym and the commoner synonyms, one of which is often the one in use in India, are added in order to prevent confusion regarding the identity of the plant following the adoption of the less known but scientifically correct name. Plants, the names of which are preceded by an asterisk (*), have been examined only in herbaria from earlier collections from the area, as these no longer grow here.

ENUMERATION OF SPECIES

GYMNOSPERMAE

PODOCARPACEAE

1. **Podocarpus brevifolius** (Stapf) Foxw. in Philip. Journ. Sci. 6: 160, t. 29, f. 2, 1911. *P. neriifolius* var. *brevifolius* Stapf.

ARAUCARIACEAE

2. **Araucaria bidwillii** Hook. in Lond. Journ. Bot. 2: 503, tt. 18 & 19, 1843.

PINACEAE

3. **Cedrus deodara** (Roxb.) G. Don in Loud. Hort. 388, 1830. *Pinus deodara* Roxb.

4. **Pinus canariensis** Sm. in Buch. Beschr. Can. Ins. 159, 1825.

*5. **Pinus echinata** Mill. Gard. Dict. (ed. 8) n. 12, 1768.

6. **Pinus insularis** Endl. Syn. Conif. 157, 1847. *P. keseya* Royle ex Endl. *P. khasiana* Griff. *P. khasya* Royle ex Parl.

*7. **Pinus pinaster** Ait. Hort. Kew. 3 : 367, 1789.

8. **Pinus pinea** L. Sp. Pl. 1000, 1753.

9. **Pinus radiata** D. Don in Trans. Linn. Soc. 17 : 442, 1837. *P. insignis* Dougl. ex Loud.

10. **Pinus roxburghii** Sarg. in Silv. N. Am. 2 : 9, 1897. *P. longifolia* Roxb.

11. **Pinus torreyana** Parr. ex Torr. in Bot. U. S. & Mex. Bound. Surv. 210, tt. 58 & 59, 1858.

12. **Pinus wallichiana** Jacks. in Kew Bull. 85, 1938. *P. excelsa* Wall. ex Lamb., non Lam. *P. nepalensis* De Chambr. *P. griffithii* McCl.

TAXODIACEAE

13. **Cryptomeria japonica** (L. f.) D. Don in Trans. Linn. Soc. Bot. 18 : 167, t. 13 (1), 1839. *Cupressus japonica* L. f.

14. **Cunninghamia lanceolata** (Lamb.) Hook. in Bot. Mag. 54 : t. 2743, 1827. *Pinus lanceolata* Lamb. *Cunninghamia sinensis* R. Br. ex Rich.

15. **Sequoia sempervirens** (Lamb.) Endl. Syn. Conif. 198, 1847. *Taxodium sempervirens* Lamb.

CUPRESSACEAE

16. **Callitris oblonga** Rich. Conif. 49, t. 18, f. 2, 1826.

17. **Callitris rhomboidea** R. Br. ex Rich. Conif. 47, t. 18, 1826; Bullock in Taxon 6 (8) : 227, 1957. *Frenela rhomboidea* Endl. *Callitris cupressiformis* Muell.

18. **Chamaecyparis lawsoniana** (Murr.) Parl. in Ann. Mus. Stor. Nat. Fir. 1 : 181, 1864. *Cupressus lawsoniana* A. Murr.

19. **Cupressus arizonica** Gr. in Bull. Torr. Cl. 9 : 64, 1882.

20. **Cupressus funebris** Endl. Syn. Conif. 58, 1847.

21. **Cupressus goveniana** Gord. in Journ. Hort. Soc. 4 : 295, 1849.

22. **Cupressus lusitanica** Mill. Gard. Dict. (ed. 8) n. 3, 1768.

23. **Cupressus macrocarpa** Hartw. in Journ. Hort. Soc. 2 : 187, 1847, nomen, et ex Gord. in Journ. Hort. Soc. Lond. 4 : 296, 1849.

24. **Cupressus sempervirens** L. Sp. Pl. 1002, 1753.

25. **Cupressus torulosa** D. Don, Prodr. 55, 1825.

26. **Libocedrus decurrens** Torr. in Sm. Inst. Contrib. Knowled. 6 (1) : 7 (Pl. Frem. 7, t. 3, 1853) 1854.

27. **Thuja orientalis** L. Sp. Pl. 1002, 1753.

28. **Widdringtonia juniperoides** (L.) Endl. Syn. Conif. 32, 1847. *Cupressus juniperoides* L. *Callitris arborea* Schrad. ex Mey.

ANGIOSPERMAE

CALYCANTHACEAE

29. **Chimonanthus praecox** (L.) Link, Enum. Pl. Hort. Berol. 2 : 66, 1822. *Calycanthus praecox* L.

MAGNOLIACEAE

30. **Magnolia campbellii** Hook. f. & Thoms. Fl. Ind. 1: 77, 1855.

31. **Magnolia grandiflora** L. Syst. (ed. 10) 2 : 1082, 1759.

32. **Magnolia liliiflora** Desr. in Lamk. Encycl. 3 : 675, 1791. *M. purpurea* Curt. *M. discolor* Vent.

PAPAVERACEAE

33. **Romneya coulteri** Harv. in Hook. Lond. Journ. Bot. 4 : 74, t. 31, 1845.

FUMARIACEAE

*34. **Corydalis lutea** (L.) DC. Fl. Fr. 4 : 638, 1812. *Fumaria lutea* L.

CRUCIFERAE

35. **Barbarea vulgaris** R. Br. in Ait. f. Hort. Kew. (ed. 2) 4 : 109, 1812.

36. **Capsella bursa-pastoris** (L.) Med. Pflanzeng. 85, 1792. *Thlaspi bursa-pastoris* L.

37. **Coronopus didymus** (L.) Sm. Fl. Brit. 2 : 691, 1800-1804. *Lepidium didymum* L. *Senebiera didyma* Pers.

38. **Nasturtium officinale** R. Br. in Ait. f. Hort. Kew. (ed. 2) 4 : 110, 1812.

*39. **Sisymbrium wolgense** Marsch. Bieb. ex Ledeb. Fl. Ross. 1 : 178, 1842, in obs., nomen nudum ; Fourn. Recherch. Crucif. 97, n. 64, 1865, descr.

FLACOURTIACEAE

40. **Aphloia mauritiana** Baker, Fl. Maurit. 12, 1877.

CARYOPHYLLACEAE

41. **Polycarpon tetraphyllum** (L.) L. Syst. (ed. 10) 881, 1759. *Mollugo tetraphylla* L.

42. **Silene gallica** L. Sp. Pl. 417, 1753.

HYPERICACEAE

43. **Hypericum hookerianum** Wt. & Arn. Prodr. 99, 1834. *H. oblongifolium* Hook. f.

SAURAUIACEAE

44. **Saurauia nepaulensis** DC. in Mem. Soc. Phys. Genev. 1 : 421, 1822.

THEACEAE

45. **Camellia japonica** L. Sp. Pl. 698, 1753. *Thea japonica* Baill.

46. **Camellia sinensis** (L.) Kuntze, Um die Erde 500, 1881, et in Act. Hort. Petrop. 10 : 195, 1887. *Thea sinensis* L. *T. bohea* L. *T. viridis* L. *T. chinensis* Sims. *Camellia thea* Link. *Thea assamica* Mast. *Camellia theifera* Griff. [Wight in Curr. Sc. 31 (7) : 298-299, 1962, again revises the nomenclature.]

47. **Schima wallichii** (DC.) Choisy in Zoll. Syst. Verz. Ind. Archip. 144, 1854. *Gordonia wallichii* DC.

MALVACEAE

48. **Abutilon megapotamicum** (Spreng.) St. Hil. & Naud. in Ann. Sc. Nat. (Ser. 2) 18 : 49, 1842. *Periptera megapotamica* (Spreng.) G. Don. *Sida megapotamica* Spreng. *Abutilon vexillarium* E. Morr.

49. **Althaea rosea** Cav. Diss. 2 : 91, t. 29, f. 3, 1786.

50. **Hibiscus rosa-sinensis** L. Sp. Pl. 694, 1753.

51. **Hibiscus syriacus** L. Sp. Pl. 695, 1753.

52. **Malvaviscus arboreus** Cav. Diss. 3 : t. 48, f. 1, 1787. *Achania malvaviscus* Swartz.

STERCULIACEAE

53. **Brachychiton acerifolius** (Cunn.) Muell. Fragm. Phyt. Austral. 1 : 1, 1858-1859. *Sterculia acerifolia* A. Cunn.

54. **Dombeya acutangula** Cav. Diss. 3 : 123, t. 38, f. 2, 1787. *Astrapaea tiliaefolia* Sw.

*55. **Dombeya burgessiae** Gerr. ex Harv. & Sond. Fl. Cap. 2, 590, 1862.

56. **Dombeya mastersii** Hook. f. in Bot. Mag. 93 : t. 5639, 1867.

57. **Dombeya wallichii** (Lindl.) K. Schum. in Pflanzenfam. 3 (4) : 78, 1890. *Astrapaea wallichii* Lindl.

GERANIACEAE

58. **Pelargonium graveolens** L'Her. Geran. t. 17, 1787-1788. *Geranium graveolens* Thunb.

59. **Pelargonium grossularioides** (L.) Ait. Hort. Kew. 2 : 420, 1789. *Geranium grossularioides* L.

OXALIDACEAE

*60. **Oxalis cernua** Thunb. Diss. Oxal. 14, t. 2, f. 2, 1781.

61. **Oxalis deppei** Lodd. Bot. Cab. 15 : t. 1500, 1828. Often erroneously named *O. tetraphylla* Cav.

62. **Oxalis latifolia** H. B. K. Nov. Gen. & Sp. 5 : 184, t. 467, 1821.

63. **Oxalis martiana** Zucc. in Denkschr. Akad. Muench. 9 : 144, 1823-1824. *O. corymbosa* DC.

64. **Oxalis pubescens** H.B.K. Nov. Gen. & Sp. 5 : 240, 1820.

65. **Oxalis variabilis** var. **rubra** Jacq. Oxal. 90, t. 53, 1794.

TROPAEOLACEAE

66. **Tropaeolum majus** L. Sp. Pl. 345, 1753.

RUTACEAE

67. **Citrus sinensis** (L.) Osbeck, Dagbok Ostind Resa 41, 1757, nomen, et Reise Ostind & China, 250, 1765. *C. aurantium* var. *sinensis* L.

68. **Choisya ternata** Kunth in H.B.K. Nov. Gen. & Sp. 6 : 6, t. 513, 1823.

69. **Euodia fraxinifolia** (Don) Hook. f. Fl. Brit. Ind. 1 : 490, 1875. *Rhus fraxinifolium* Don.

*70. **Ruta graveolens** L. Sp. Pl. 383, 1753.

AQUIFOLIACEAE

*71. **Ilex aquifolium** L. Sp. Pl. 125, 1753.

72. **Ilex opaca** Ait. Hort. Kew. 1 : 169, 1789.

RHAMNACEAE

73. **Colletia cruciata** Gill. ex Hook. in Hook. Bot. Misc. 1 : 152, t. 43, 1829.

74. **Hovenia dulcis** Thunb. Fl. Jap. 101, 1784.

*75. **Noltea africana** (L.) Reichb. ex Harv. & Sond. Fl. Cap. 1 : 478, 1859-1860. *Ceanothus africanus* L.

76. **Pomaderris lanigera** Sims in Bot. Mag. 43 : t. 1823, 1816.

MELIANTHACEAE

77. **Melianthus major** L. Sp. Pl. 639 (err. typ. 939), 1753.

HIPPOCASTANACEAE

78. **Aesculus indica** (Camb.) Hook. in Bot. Mag. 85 : t. 5117, 1859. *A. indica* Colebr. *Pavia indica* Wall. ex Camb.

ACERACEAE

*79. **Acer caesium** Wall. ex Brandis, For. Fl. 111, t. 21, 1874.

80. **Acer pseudo-platanus** L. Sp. Pl. 1054, 1753.

ANACARDIACEAE

81. **Schinus molle** L. Sp. Pl. 388, 1753.

PAPILIONACEAE

*82. **Castanospermum australe** A. Cunn. & Fras. in Hook. Bot. Misc. 1 : 241, t. 51, 1830.

*83. **Chorizema ilicifolium** Labill. Voy. 1 : 405, 1800.

84. **Crotalaria agatiflora** Schweinf. ex Engl. in Abhandl. Preuss. Akad. Wiss. 1891, 2 : 244, 1892, nomen, et in Hoehnel. zum Rudolph. Append. 13, 1892.

*85. **Erythrina crista-galli** L. Mant. 1 : 99, 1767.

*86. **Hardenbergia comptoniana** (Link) Benth. in Endl. & Fenzl, Enum. Pl. Hueg. 41, 1837. *Kennedya comptoniana* Link.

87. **Laburnum anagyroides** Med. in Vorl. Kurp. Ges. 2 : 363, 1787.

*88. **Robinia pseudoacacia** L. Sp. Pl. 722, 1753.

89. **Sarothamnus scoparius** (L.) W. D. J. Koch, Syn. Fl. Germ. Helv. 152, 1837. *Spartium scoparium* L. *Cytisus scoparius* (L.) Link.

90. **Spartium junceum** L. Sp. Pl. 708, 1753. *Genista juncea* Scop.

91. **Trifolium dubium** Sibth. Fl. Oxon. 231, 1794.

*92. **Trifolium pratense** L. Sp. Pl. 768, 1753.

93. **Trifolium repens** L. Sp. Pl. 767, 1753.

94. **Ulex europeus** L. Sp. Pl. 241, 1753.

95. **Wisteria sinensis** (Sims) Sw. Hort. Brit. 121, 1827. *Glycine sinensis* Sims. *Wisteria chinensis* DC.

CAESALPINIACEAE

96. **Cassia didymobotrya** Fresen. in Flora 22 (1) : 53, 1839 ; de Wit in Webbia 11 : 241, 1955.

97. **Cassia laevigata** Willd. Enum. Hort. Berol. 441, 1809.

98. **Cassia tomentosa** L. f. Supp. 231, 1781 ; de Wit in Webbia 11 : 275, 1955.

*99. **Ceratonia siliqua** L. Sp. Pl. 1026, 1753.

100. **Schizolobium excelsum** Vog. in Linn. 11 : 399, 1837.

MIMOSACEAE

101. **Acacia baileyana** Muell. in Trans. & Proc. Roy. Soc. Vic. 24 : 168, 1888.

*102. **Acacia cunninghamii** Hook. Ic. Pl. t. 165, 1837.

103. **Acacia cyanophylla** Lindl. Bot. Reg. (Misc.) 49, 1839.

104. **Acacia dealbata** Link, Enum. Hort. Berol. 445, 1822. *A. decurrens* (Wendl.) Willd. var. *dealbata* Muell. ex Maiden.

105. **Acacia decurrens** (Wendl.) Willd. Sp. Pl. 4 : 1072, 1806. *Mimosa decurrens* Wendl.

106. **Acacia elata** A. Cunn. ex Benth. in Hook. Lond. Journ. Bot. 1 : 383, 1842.

107. **Acacia lindleyi** Meissn. in Lehm. Pl. Preiss. 1 : 14, 1844.

108. **Acacia longifolia** Willd. Sp. Pl. 4 : 1052, 1806.

109. **Acacia maidenii** Muell. in Macl. Mem. Linn. Soc. N. S. Wales 222, t. 29, 1893.

110. **Acacia mearnsii** ('mearnsi') De Willd. Pl. Bequaert. 3 : 61, 1925 ; Brenan & Melville in Kew Bull. 37-39, 1960. *A. decurrens* (Wendl.) Willd. var. *mollis* Lindl. *A. mollissima* sensu auct. mult. e.g. Benth. in Hook. Lond. Journ. Bot. 1 : 385, 1842, *non* Willd. [quae = *A. pubescens* (Vent.) Ait. f. Hort. Kew. (ed. 2) 5 : 467, 1813].

111. **Acacia melanoxylon** R. Br. in Ait. f. Hort. Kew. (ed. 2) 5 : 462, 1813.

112. **Acacia podalyriifolia** A. Cunn. in G. Don, Syst. 2 : 405, 1832.

*113. **Acacia retinodes** Schlecht. in Linn. 20 : 664, 1847, et in Bot. Zeit. 11 : 893, 1853.

114. **Albizia distachya** (Vent.) Macb. in Contrib. Gray Herb. (N.S.) 59 : 3, 1919. *Mimosa distachya* Vent. *Albizia lophantha* (Willd.) Benth. *Acacia lophantha* Willd.

115. **Leucaena leucocephala** (Lam.) de Wit in Taxon 10 (2) : 54, 1961. *Mimosa leucocephala* Lam. *Acacia glauca* (L.) Willd. *Mimosa glauca* L. *Leucaena glauca* (Willd.) Benth.

ROSACEAE

116. **Chaenomeles lagenaria** (Loisel) Koidz. in Bot. Mag. Tok. 23: 173, 1909. *Cydonia lagenaria* Loisel. *Pyrus japonica* Sims. *P. cydonia* Lour. *Malus japonica* Andr.

117. **Eriobotrya japonica** (Thunb.) Lindl. in Trans. Linn. Soc. Lond. 13 : 102, 1821. *Mespilus japonica* Thunb.

118. **Malus baccata** (L.) Borkh. Handb. Forstbot. 2 : 1280, 1803. *Pyrus baccata* L.

119. **Malus sylvestris** (L.) Mill. Gard. Dict. (ed. 8) n. 1, 1768. *Pyrus malus* var. *sylvestris* L.

*120. **Prinsepia utilis** Royle, Ill. Bot. Himal. 206, t. 38, f. 1, 1834, et 202 & 206, 1835.

*121. **Prunus armeniaca** L. Sp. Pl. 474, 1753.

122. **Prunus cerasoides** D. Don, Prodr. 239, 1825. *P. silvatica* Roxb. *Cerasus phoshia* Hamilt. ex D. Don. *Prunus puddum* Roxb. ex Brandis.

*123. **Prunus domestica** L. Sp. Pl. 475, 1753, p.p. typ.

124. **Prunus persica** (L.) Batsch, Beytr. Entw. Pragm. Gesch. Naturr. 30, 1801. *Amygdalus persica* L. *Persica vulgaris* Mill.

125. **Prunus salicina** Lindl. in Trans. Hort. Soc. Lond. 7 : 239, 1828. *Prunus triflora* Roxb.

126. **Pyrus communis** L. Sp. Pl. 459, 1753.

127. **Rosa banksiae** Ait. f. Hort. Kew. (ed. 2) 3 : 258, 1811. *R. inermis* Roxb.

128. **Rosa centifolia** L. Sp. Pl. 491, 1753.

129. **Rosa damascena** Mill. Gard. Dict. (ed. 8) n. 15, 1768.

130. **Spiraea canescens** D. Don, Prodr. 227, 1825.

131. **Spiraea cantoniensis** Lour. Fl. Cochinch. 1 : 322, 1790. *S. corymbosa* Roxb.

PHILADELPHACEAE

132. **Deutzia gracilis** Sieb. & Zucc. Fl. Jap. 1 : 22, t. 8, 1835.

133. **Deutzia scabra** Thunb. Fl. Jap. 185, t. 24, 1784.

134. **Philadelphus coronarius** L. Sp. Pl. 470, 1753.

HYDRANGEACEAE

135. **Hydrangea macrophylla** (Thunb.) Ser. in DC. Prodr. 4: 15, 1830. *Viburnum macrophyllum* Thunb. *Hortensia opuloides* Lamk. *Hydrangea hortensis* Sm. *H. hortensia* (Lamk.) Sieb.

ESCALLONIACEAE

136. **Escallonia macrantha** Hook. & Arn. in Hook. Bot. Misc. 3: 341, 1833.

HAMAMELIDACEAE

137. **Liquidambar styraciflua** L. Sp. Pl. 999, 1753.

138. **Symingtonia populnea** (R. Br.) Steen. in Act. Bot. Neerl. 1: 444, 1952; Vink in Fl. Mal. 1, 5(3): 375, f. 7, 1958. *Bucklandia populnea* R. Br. *Liquidambar tricuspis* Miq. *Bucklandia populifolia* Hook. f. & Thoms. *B. tricuspis* Hall. f. *Exbucklandia populnea* R. W. Brown.

MYRTACEAE

139. **Angophora costata** (Gaertn.) Britt. in Journ. Bot. 54: 62, 1916. *Metrosideros costata* Gaertn. *Angophora lanceolata* Cav.

140. **Baeckea virgata** (Forst.) Andr. Bot. Rep. 598, 1810. *Leptospermum virgatum* Forst.

141. **Callistemon brachyandrus** Lindl. in Journ. Hort. Soc. 4: 112, 1849.

142. **Callistemon citrinus** (Curt.) Stapf in Bot. Mag. 150: t. 9050, 1925. *Metrosideros citrina* Curt. *Callistemon lanceolatus* DC.

143. **Eucalyptus calophylla** R. Br. ex Lindl. in Bot. Reg. (App.) 157, 1841.

144. **Eucalyptus citriodora** Hook. in Mitch. Journ. Exped. Trop. Austral. 235, 1848. *E. maculata* var. *citriodora* Muell.

*145. **Eucalyptus cladocalyx** Muell. in Linnea 25: 388, 1852. *E. corynocalyx* Muell.

146. **Eucalyptus crebra** Muell. in Journ. Linn. Soc. 3: 87, 1858.

147. **Eucalyptus diversicolor** Muell. Fragm. Phytogr. Austral. 3: 131, 1863.

148. **Eucalyptus ficifolia** Muell. Fragm. Phytogr. Austral. 2: 85, 1860, et 6: 25, 1867.

149. **Eucalyptus globulus** Labill. Rel. Voy. Recher. Per. 1: 153, t. 13, 1799.

150. **Eucalyptus longifolia** Link, Enum. Pl. Hort. Reg. Berol. 2: 29, 1822.

151. **Eucalyptus macarthurii** Deane & Maiden in Proc. Linn. Soc. N. S. Wales 24: 448, 1882.

152. **Eucalyptus nova-anglica** Deane & Maiden in Proc. Linn. Soc. N. S. Wales 24 : 616, 1882.

153. **Eucalyptus obliqua** L'Herit. Sert. Angl. 18, t. 20, 1788.

154. **Eucalyptus piperita** Sm. in Wh. Journ. Voy. N. S. Wales, 226, 1790.

155. **Eucalyptus radiata** Sieb. ex DC. Prodr. 3 : 218, 1828.

156. **Eucalyptus regnans** Muell. in Rep. Acclim. Soc. Vict. 20, 1870.

157. **Eucalyptus robusta** Sm. Spec. Bot. New Holl. 40, t. 13, 1793, et in Trans. Linn. Soc. 3 : 283, 1796.

158. **Eucalyptus rossii** R. T. Baker & H. G. Sm. Res. Euc. 70, 1889.

159. **Eucalyptus sieberiana** Muell. Eucalyptogr. Dec. 2, 1879.

160. **Eucalyptus tereticornis** Sm. Spec. Bot. New Holl. 41, 1793, et in Trans. Linn. Soc. 3 : 284, 1797.

161. **Eucalyptus viminalis** Labill. Nov. Holl. Pl. Spec. 2 : 12, t. 151, 1806.

162. **Feijoa sellowiana** (Berg) Berg in Linnea 29 : 258, 1858. *Orthostemon sellowianus* Berg.

163. **Leptospermum scoparium** Forst. Char. Gen. 71, t. 36, 1776.

164. **Melaleuca styphelioides** Sm. in Trans. Linn. Soc. 3 : 275, 1797.

165. **Myrtus communis** L. Sp. Pl. 471, 1753.

166. **Syncarpia glomulifera** (Sm.) Nied. in Pflanzenfam. 3 (7) : 88, 1893. *Metrosideros glomulifera* Sm. *Syncarpia laurifolia* Ten.

167. **Tristania conferta** R. Br. in Ait. f. Hort. Kew, (ed. 2) 4 : 417, 1812.

MELASTOMACEAE

168. **Tibouchina semidecandra** Cogn. in Mart. Fl. Bras. 14 (3) : 365, 1817-1820.

LYTHRACEAE

169. **Lagerstroemia indica** L. Sp. Pl. (ed. 2) 734, 1762.

ONAGRACEAE

170. **Fuchsia boliviana** Carr. var. **luxurians** Johnston, Rev. Hort. 150, 1876.

171. **Fuchsia magellanica** Lamk. Encycl. 2 : 564, 1788. *F. coccinea* Curt. *F. macrostemma* Ruiz & Pav.

172. **Oenothera biennis** L. Sp. Pl. 346, 1753.

*173. **Oenothera nocturna** Jacq. Coll. 3 : 205, 1790, et Ic. Pl. Rar. 3 (3) : 455, 1789.

174. **Oenothera odorata** Jacq. Ic. Pl. Rar. 3 (3) : t. 456, 1789, et Coll. Suppl. 107, 1790.

175. **Oenothera rosea** Ait. Hort. Kew. 2 : 3, 1789.

176. **Oenothera tetraptera** Cav. Ic. 3 : 40, t. 279, 1794.

PASSIFLORACEAE

177. **Passiflora antioquiensis** Karst. in Linn. 30 : 162, 1859.

178. **Passiflora caerulea** L. Sp. Pl. 959, 1753.

179. **Passiflora calcarata** Mast. in Trans. Linn. Soc. 27 : 638, 1871.

180. **Passiflora edulis** Sims in Bot. Mag. 45 : t. 1989, 1818.

181. **Passiflora mollissima** (H.B.K.) Bailey in Rhod. 18 : 156, 1916. *Tacsonia mollissima* H.B.K.

CARICACEAE

182. **Carica cundinamarcensis** Lind. Cat. 87, 1871. *C. candamarcensis* Hook. f.

ARALIACEAE

183. **Hedera helix** L. Sp. Pl. 202, 1753.

184. **Tetrapanax papyrifer** (Hook.) C. Koch & Fint, Woch. 2 : 371, 1859. *Aralia papyrifera* Hook. *Fatsia papyrifera* Hook.

CAPRIFOLIACEAE

185. **Lonicera sempervirens** L. Sp. Pl. 173, 1753.

RUBIACEAE

186. **Cinchona calisaya** Wedd. in Ann. Sc. Nat. (Ser. 3) 10 : 6, 1848.

187. **Cinchona calisaya** var. **ledgeriana** How. Quin. E. Ind. Pl. 86, tt. 4-6, 1876.

188. **Cinchona officinalis** L. Syst. (ed. 10) 929, 1759, et Sp. Pl. (ed. 2) 244, 1763. *C. condaminea* H.B.

189. **Cinchona succirubra** Pav. ex Klot. in Abh. Akad. Berl. 60, 1857.

190. **Coffea arabica** L. Sp. Pl. 172, 1753.

191. **Luculia gratissima** Sw. Brit. Fl. Gard. t. 145, 1823. *Cinchona gratissima* Wall. ex Roxb.

192. **Luculia pinceana** Hook. in Bot. Mag. 71 : t. 4132, 1845.

COMPOSITAE

193. **Ageratum houstonianum** Mill. Gard. Dict. (ed. 8) n. 2, 1768. *A. mexicanum* Sims.

194. **Chrysanthemum cinerariifolium** (Trev.) Vis. Fl. Dalmat. 2 : 88, t. 8, 1842-1852. *Pyrethrum cinerariaefolium* Trev.

195. **Chrysanthemum frutescens** L. Sp. Pl. 887, 1753.

196. **Cotula australis** Hook. f. Fl. Nov. Zel. 128, 1852.

197. **Dahlia imperialis** Roezl in Gartenfl. 12 : 243, tt. 407 & 408, 1863, et 56 : 22, 1907.

198. **Erechthites valerianiifolia** (Wolf.) DC. Prodr. 6 : 295, 1838. *Senecio valerianaefolius* Wolf.

199. **Erigeron bonariensis** L. Sp. Pl. 863, 1753. *E. linifolius* Willd. *Conyza ambigua* DC.

200. **Erigeron canadensis** L. Sp. Pl. 863, 1753.

201. **Erigeron karvinskianus** DC. Prodr. 5 : 285, 1836. *E. mucronatus* DC.

202. **Eupatorium glandulosum** H.B.K. Nov. Gen. & Sp. 4 : 122, 1820. *E. adenophorum* Spreng.

203. **Galinsoga parviflora** Cav. Ic. 3 : 41, t. 281, 1794.

204. **Helichrysum bracteatum** Andr. Bot. Rep. sub. t. 428, 1805, et Willd. Enum. Hort. Berol. 896, 1809.

205. **Hypochoeris glabra** L. Sp. Pl. 811, 1753.

206. **Montanoa bipinnatifida** C. Koch, Woch. 7 : 406, 1864.

207. **Santolina chamaecyparissus** L. Sp. Pl. 842, 1753.

208. **Sonchus brachyotus** DC. Prodr. 7 : 186, 1838. [L. Boulos in Bot. Notiser 114 (1) : 57-64, 1961, points out that this species is often confused with *S. arvensis* L.]

209. **Sonchus oleraceus** L. Sp. Pl. 794, 1753.

210. **Taraxacum officinale** Web. in Wigg. Prim. Fl. Hols. 56, 1780.

211. **Tithonia diversifolia** Gray in Proc. Am. Acad. 19 : 5, 1883.

ERICACEAE

212. **Calluna vulgaris** (L.) Hull, Brit. Fl. (ed. 2) 1 : 114, 1808. *Erica vulgaris* L.

213. **Erica vagans** L. Diss. Bot. Er. 10, 1770, et Mant. 2 : 230, 1771.

214. **Rhododendron indicum** (L.) Sw. Hort. Brit. (ed. 2) 343, 1830, et Brit. Fl. Gard. (Ser. 2) 2 : t. 128, 1883. *Azalea indica* L.

*215. **Rhododendron mucronatum** (Bl.) G. Don, Gen. Syst. 3 : 846, 1843. *Azalea mucronata* Bl.

*216. **Rhododendron ponticum** L. Sp. Pl. (ed. 2) 562, 1762.

*217. **Rhododendron simsii** Planch. in Fl. Serr. 9 : 78, 1854.

OLEACEAE

218. **Jasminum mesnyi** Hance in Journ. Bot. 20 : 37, 1862. *J. primulinum* Hemsl. ex Baker.

219. **Jasminum officinale** L. Sp. Pl. 7, 1753.

APOCYNACEAE

220. **Mandevilla laxa** (Ruiz & Pav.) Woods. in Ann. Miss. Bot. Gard. 19: 68, 1932, et 20: 695, 1933. *Echites laxa* Ruiz & Pav. *Mandevilla suaveolens* Lindl.

221. **Nerium indicum** Mill. Gard. Dict. (ed. 8) n. 2, 1768. *N. odorum* Ait. *N. odoratum* Lamk.

222. **Plumeria rubra** L. Sp. Pl. 209, 1753. *P. rubra* L. forma *acutifolia* (Poir.) Woods. *P. acutifolia* Poir. *P. acuminata* Ait.

223. **Vinca major** L. Sp. Pl. 209, 1753.

ASCLEPIADACEAE

224. **Gomphocarpus fruticosus** (L.) Ait. f. Hort. Kew. (ed. 2) 2: 80, 1811. *Asclepias fruticosa* L.

BUDDLEJACEAE

225. **Buddleja davidii** Franch. in Nouv. Mus. Hist. Nat. Par. (Ser. 2) 10: 65, 1887. *B. variabilis* Hemsl.

226. **Buddleja madagascariensis** Lamk. Encycl. 1 : 513, 1785. *B. heterophylla* Lindl.

COBAEACEAE

227. **Cobaea scandens** Cav. Ic. 1 : 15, tt. 16 & 17, 1791.

CONVOLVULACEAE

228. **Ipomoea congesta** R. Br. Prodr. 485, 1810; Ooststr. in Blumea 3 : 500, 1940, et in Fl. Mal. 1, 4 (4) : 465, 1953. *Pharbitis learii* Lindl. *Ipomoea learii* Paxt.

SOLANACEAE

229. **Brugmansia suaveolens** (H.B.) Bercht. & Presl. Rostl. 1, Solan. 45, ? 1824. *Datura suaveolens* H.B. ex Willd.

230. **Cestrum aurantiacum** Lindl. Bot. Reg. 30 : 71, n. 65, 1844, et 31 : t. 22, 1845.

231. **Cestrum elegans** (Brongn.) Schlecht. in Linnea 19 : 261, 1847 ; Francey in Candollea 6 : 123, 1934-1936. *Habrothamnus elegans* Brongn. ex Neum. *H. purpureus* Lindl. *Cestrum purpureum* (Lindl.) Standl.

232. **Cestrum fasciculatum** (Schlecht.) Miers in Hook. Lond. Journ. Bot. 5 : 151, 1846 ; Francey in Candollea 6 : 113, 1934-1936. *Meyenia fasciculata* Schlecht. *Habrothamnus fasciculatus* Brongn.

233. **Cestrum nocturnum** L. Sp. Pl. 191, 1753.

234. **Cyphomandra betacea** (Cav.) Sendt. in Flora 28 : 172, 1845. *Solanum betaceum* Cav.

235. **Nicandra physalodes** (L.) Gaertn. Fruct. 2 : 237, t. 131, f. 2, 1791. *Atropa physalodes* L.

236. **Physalis peruviana** L. Sp. Pl. (ed. 2) 1670, 1763. *P. edulis* Sims.

237. **Solanum jasminoides** Paxt. Mag. Bot. 8 : t. 5, 1841.

238. **Solanum pseudo-capsicum** L. Sp. Pl. 184, 1753.

*239. **Solanum sisymbriifolium** Lamk. Ill. 2 : 25, 1792.

240. **Solanum wendlandii** Hook. f. in Bot. Mag. 113 : t. 6914, 1887.

241. **Streptosolen jamesonii** (Benth.) Miers in Ann. & Mag. Nat. Hist. (Ser. 2) 5 : 208, 1850. *Browallia jamesonii* Benth.

SCROPHULARIACEAE

242. **Calceolaria mexicana** Benth. Pl. Hartw. 47, 1839.

243. **Cymbalaria muralis** (L.) Gaertn., Mey. & Scherb. Fl. Wett. 2 : 397, 1799-1802. *Antirrhinum cymbalaria* L. *Linaria cymbalaria* Mill.

244. **Digitalis purpurea** L. Sp. Pl. 621, 1753.

245. **Hebe andersonii** (Lindl. & Paxt.) Cock. in Trans. & Proc., N. Z. Inst. 60 : 468, 1929. *Veronica andersonii* Lindl. & Paxt.

246. **Maurandia barclaiana** Lindl. Bot. Reg. 13 : t. 1108, 1827.

*247. **Verbascum thapsus** L. Sp. Pl. 177, 1753.

248. **Verbascum virgatum** Stokes in With. Bot. Arr. Brit. Pl. (ed. 2) 1 : 227, 1787-1792.

BIGNONIACEAE

249. **Bignonia unguis-cati** L. Sp. Pl. 623, 1753. *B. gracilis* Lodd.

250. **Campsis radicans** (L.) Seem. in Journ. Bot. 5 : 372, 1867. *Bignonia radicans L.*

251. **Catalpa bignonioides** (L.) Walt. Fl. Carol. 64, 1788. *Bignonia catalpa* L.

252. **Jacaranda mimosifolia** D. Don in Bot. Reg. 8 : t. 631, 1822. *J. ovalifolia* R. Br.

253. **Pandorea jasminoides** (Lindl.) Schum. in Pflanzenfam. 4 (3 b) : 230, 1894. *Tecoma jasminoides* Lindl.

254. **Phaedranthus buccinatorius** (DC.) Miers in Proc. Roy. Hort. Soc. 3 : 182, 1863. *Pithecoctenium buccinatorium* DC. *Bignonia cherere* Lindl.

255. **Phyllarthron comorense** DC. ex Meissn. Gen. 244, 1840. *Arthrophyllum comorense* Boj.

256. **Podranea ricasoliana** (Tanf.) Sprague in Dyer, Fl. Cap. 4 (2) : 450, 1904. *Tecoma ricasoliana* Tanf.

257. **Pyrostegia venusta** (Ker-Gawl.) Presl. Bot. Bemerk. 93, 1845. *Bignonia venusta* Ker-Gawl. *B. ignea* Vell. *Tecoma venusta* Lem. *Pyrostegia ignea* (Vell.) Presl.

*258. **Tecoma mollis** H. B. K. Gen. & Sp. 3 : 144, 1819.

259. **Tecoma stans** (L.) H.B.K. Nov. Gen. & Spec. 3 : 144, 1819. *Bignonia stans* L.

260. **Tecomaria capensis** (Thunb.) Spach, Hist. Nat. Veg. 9 : 137, 1840. *Bignonia capensis* Thunb. *Tecoma capensis* Lindl.

ACANTHACEAE

261. **Acanthus mollis** L. Sp. Pl. 639, (err. typ. 939) 1753.

VERBENACEAE

262. **Aloysia triphylla** (L'Herit.) Britt. in Sc. Surv. Port. Ric. & Virg. Isl. 6 : 140, 1925. *Verbena triphylla* L'Herit. *Aloysia citriodora* Ort. ex Pers. *Lippia citriodora* H.B.K.

263. **Clerodendrum fragrans** var. **pleniflorum** Schauer in DC. Prodr. 11 : 666, 1847. *C. fragrans* auct. non R. Br.

264. **Duranta repens** L. Sp. Pl. 637, 1753. *D. plumieri* Jacq.

265. **Holmskioldia sanguinea** Retz. Obs. Bot. 6 : 31, 1791.

266. **Lantana camara** var. **aculeata** (L.) Mold. in Torreya 9 : 34, 1934, et in Lilloa 4 : 289, 1939. *L. aculeata* L. *L. camara* auct. non L. nisi pro parte. *L. scabrida* Ait. f.

267. **Verbena bipinnatifida** Schauer in DC. Prodr. 11 : 553, 1847.

268. **Verbena bonariensis** L. Sp. Pl. 20, 1753.

269. **Verbena rigida** Spreng. Syst. 4 (Cur. Post.) 230, 1827. *V. venosa* Gill & Hook.

LABIATAE

270. **Rosmarinus officinalis** L. Sp. Pl. 23, 1753.

271. **Salvia leucantha** Cav. Ic. 1 : 16, t. 24, 1791.

NYCTAGINACEAE

272. **Bougainvillea buttiana** Holtt. & Standl. in Publ. Field Mus. Nat. Hist. Chic. (Bot. Ser.) 23 : 44, 1944.

273. **Bougainvillea glabra** Choisy in DC. Prodr. 13(2) : 437, 1849.

AMARANTHACEAE

274. **Alternanthera ficoidea** (L.) R. Br. ex R. & S. Syst. 5 : 555, 1819, var. **bettzickiana** (Nich.) Back. in Fl. Mal. 1, 4 (2) : 93, 1949. *Gomphrena ficoidea* L. *Alternanthera bettzichiana* (Regel) Nich. *Telanthera bettzichiana* Regel.

275. **Iresine herbstii** Hook. f. Gard. Chron. 654 & 1206, 1864.

PHYTOLACCACEAE

276. **Phytolacca dioica** L. Sp. Pl. (ed. 2) 632, 1762.

277. **Phytolacca octandra** L. Sp. Pl. (ed. 2) 631, 1762.

POLYGONACEAE

278. **Fagopyrum esculentum** Moench, Meth. 290, 1794.

*279. **Rumex acetosella** L. Sp. Pl. 538, 1753.

LAURACEAE

280. **Persea americana** Mill. Gard. Dict. (ed. 8) 1768. *P. gratissima* Gaertn. f.

PROTEACEAE

*281. **Banksia marginata** R. Br. Prodr. 392, 1810, et in Trans. Linn. Soc. 10 : 204, 1811. *B. australis* R. Br.

282. **Grevillea robusta** A. Cunn. in R. Br. Prot. Nov. 24, 1830.

*283. **Hakea acicularis** Knight, Prot. 107, 1809.

284. **Hakea salicifolia** (Vent.) Burtt in Kew Bull. 33, 1941. *Embothrium salicifolium* Vent. *E. salignum* Andr. *Hakea saligna* (Andr.) Kn.

BUXACEAE

285. **Buxus sempervirens** L. Sp. Pl. 983, 1753.

EUPHORBIACEAE

286. **Acalypha wilkesiana** Muell.-Arg. in DC. Prodr. 15 (2): 817, 1866. *A. tricolor* Hort. ex Seem.

287. **Euphorbia milii** Desmoul. in Bull. Hist. Nat. Soc. Linn. Bord. 1 : 27, 1826. *E. splendens* Boj. ex Hook.

288. **Euphorbia pulcherrima** Willd. ex Klot. in Otto & Dietr. Allg. Gartenz. 2 : 27, 1834. *Poinsettia pulcherrima* Grah.

289. **Ricinus communis** L. Sp. Pl. 1007, 1753.

MORACEAE

290. **Ficus carica** L. Sp. Pl. 1059, 1753.

*291. **Ficus elastica** Roxb. Hort. Beng. 65, 1814, nomen, et Fl. Ind. (ed. 2) 3 : 541, 1832.

292. **Ficus pumila** L. Sp. Pl. 1060, 1753.

293. **Morus australis** Poir. Encycl. 4 : 380, 1727 ; Nakai in Journ. Arn. Arb. 8 : 236, 1927 ; Rehder in Journ. Arn. Arb. 10 : 123, 1929. *M. indica* Thunb., non L., pro parte. *M. acidosa* Griff. *M. alba* var. *indica* Bureau.

PLATANACEAE

294. **Platanus orientalis** L. Sp. Pl. 999, 1753.

JUGLANDACEAE

295. **Juglans regia** L. Sp. Pl. 997, 1753.

CASUARINACEAE

296. **Casuarina suberosa** Otto & Dietr. Allg. Gartenz. 155, 1841.
297. **Casuarina torulosa** Ait. Hort. Kew. 3: 320, 1789.

BETULACEAE

298. **Alnus nepalensis** D. Don. Prodr. 58, 1825.
299. **Betula alnoides** Buch.-Ham. ex D. Don, Prodr. 58, 1825.

FAGACEAE

300. **Castanea sativa** Mill. Gard. Dict. (ed. 8) n. 1. 1768. *Castanea vulgaris* Lamk.

301. **Castanopsis indica** (Roxb.) DC. in Journ. Bot. 1: 182, 1863. *Castanea indica* Roxb.

302. **Fagus sylvatica** L. Sp. Pl. 998, 1753.

*303. **Quercus ilex** L. Sp. Pl. 995, 1753.

304. **Quercus incana** Roxb. Hort. Beng. 104, 1814, nomen, et Fl. Ind. (ed. 2) 3: 642, 1832.

305. **Quercus robur** L. Sp. Pl. 996, 1753.

SALICACEAE

306. **Salix babylonica** L. Sp. Pl. 1017, 1753.

MUSACEAE

307. **Ensete edule** Horan. Prodr. Scit. 41, 1862; Chessman in Kew Bull. 100, 1947. *Musa ensete* Gmel.

*308. **Musa basjoo** Sieb. in Verh. Batav. Gen. 12: 18, 1830. *M. japonica* Hort.

309. **Musa ? paradisiaca** L. Sp. Pl. 1043, 1753; Chessman in Kew Bull. 106-117, 1947.

LILIACEAE

*310. **Eucomis undulata** Ait. Hort. Kew. 1: 433, 1789.

311. **Kniphofia uvaria** (L.) Hook. in Bot. Mag. 80: t. 4816, 1854. *Aloe uvaria* L. *Aletris uvaria* L. *Kniphofia aloides* Moench.

RUSCACEAE

312. **Ruscus aculeatus** L. Sp. Pl. 1041, 1753.

AMARYLLIDACEAE

313. **Agapanthus africanus** (L.) Hoffmgg. Verz. Pfl. 35, 1824. *Crinum africanum* L. *Agapanthus umbellatus* L'Herit.

314. **Agapanthus orientalis** Leight. in Journ. S. Afr. Bot. 5 : 57, var. **albus** Hort. Chitt. Dict. Gard. 62, 1951.

IRIDACEAE

315. **Watsonia ardernei** Math. & Bol. in Ann. Bol. Herb. 4 : 25, 1925.

AGAVACEAE

316. **Cordyline australis** (Forst.) Hook. f. Fl. Nov. Zel. 1 (4): 257, 1853, et in Gard. Chron. 792, 1860. *Dracaena australis* Forst.

317. **Furcraea foetida** (L.) Haw. Suppl. Pl. Succ. 73, 1819. *Agave foetida* L. *Furcraea gigantea* Vent.

318. **Phormium tenax** Forst. Char. Gen. 48, 1775.

PALMAE

319. **Livistona rotundifolia** (Lamk.) Mart. Hist. Nat. Palm. 3: 241, t. 102, 1837. *Corypha rotundifolia* Lamk.

*320. **Phoenix rupicola** T. And. in Journ. Linn. Soc. 11 : 13, 1871.

321. **Sabal mauritiiformis** (Karst.) Gr. & Wendl. in Griseb. Fl. Brit. W. Ind. 514, 1864. *Trithrinax mauritiaeformis* Karst.

322. **Trachycarpus fortunei** (Hook.) Wendl. in Bull. Soc. Fr. 8: 429, 1861. *Chamaerops fortunei* Hook. *Trachycarpus excelsa* Wendl.

323. **Washingtonia robusta** Wendl. in Berl. Gaertn. Zeit. 2: 198, 1883.

ARACEAE

324. **Zantedeschia aethiopica** (L.) Spreng. Syst. 3 : 715, 1826. *Calla aethiopica* L. *Richardia africana* Kunth. *R. aethiopica* Spreng. *Colocasia aethiopica* Spreng.

GRAMINEAE

*325. **Anthoxanthum hookeri** (Griseb.) Rendle in Journ. Linn. Soc. (Bot.) 36 : 380, 1904. *Ataxia hookeri* Griseb.

326. **Anthoxanthum odoratum** L. Sp. Pl. 28, 1753.

327. **Brachypodium sylvaticum** (Huds.) P. Beauv. Ess. Agrost. 101 & 155, 1812. *Festuca sylvatica* Huds.

328. **Briza maxima** L. Sp. Pl. 70, 1753.

*329. **Briza media** L. Sp. Pl. 70, 1753.

*330. **Briza minor** L. Sp. Pl. 70, 1753.

331. **Bromus unioloides** H. B. K. Nov. Gen. & Sp. 1 : 151, 1816. *Festuca unioloides* Willd. *Bromus unioloides* (Willd.) Rasp. *Ceratochloa unioloides* (Willd.) P. Beauv. *Bromus catharticus* Vahl.

332. **Cortaderia selloana** (Schult.) Aeschers. & Graebn. Syn. Mittel. 2 : 325, 1900. *Arundo selloana* Schult. *Gynerium argenteum* Nees; *Cortaderia argentea* (Nees) Stapf.

333. **Dactylis glomerata** L. Sp. Pl. 71, 1753.

334. **Eragrostis curvula** (Schrad.) Nees, Fl. Afr. Aust. 397, 1841. *Poa curvula* Schrad.

335. **Festuca ovina** L. Sp. Pl. 73, 1753.

336. **Lolium perenne** L. Sp. Pl. 83, 1753.

*337. **Miscanthus nepalensis** (Trin.) Hack. in DC. Monogr. Phan. 6 : 104, 1889. *Eulalia nepalensis* Trin.

338. **Panicum maximum** Jacq. Coll. Bot. 1 : 76, 1786, et Ic. Pl. Rar. 1 : 2, t. 13, 1781-1786.

339. **Paspalum dilatatum** Poir. in Lamk. Encycl. 5 : 35, 1804.

340. **Pennisetum clandestinum** Hochst. ex Chiov. in Ann. Ist. Bot. Rom. 8 : 41, t. 5, f. 2, 1903.

341. **Pennisetum purpureum** Schumach. Beskr. Guin. Pl. 44, 1827.

342. **Phalaris tuberosa** L. Mant. 2 : 557, 1771.

343. **Poa annua** L. Sp. Pl. 68, 1753.

344. **Vulpia myuros** (L.) Gmel. Fl. Bad. 1 : 8, 1806. *Festuca myuros* L.

A Note on the Mantids and Tettigonids in the collection of the Bombay Natural History Society

BY

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While rearranging the insect collections of the Bombay Natural History Society, a few boxes containing Orthopteran insects were found divided into their families, of which two, the Acridids and Tettigonids, were largely identified specifically; the other families, Blattidae, Mantidae, Phasmidae, and Gryllidae, had been left alone. A search for relevant literature revealed that, except for Kirby's FAUNA OF BRITISH INDIA on Acridiidae (1914) and his A SYNONYMIC CATALOGUE OF ORTHOPTERA in 3 volumes (1904-1910), no consolidated taxonomic work is available. In subsequent years a large number of species and genera have been established and described in scattered periodicals and journals, mostly in languages other than English. Upon a reference being made to the British Museum (Natural History), London, Dr. David R. Ragge of the Entomology Department replied: 'The Phasmatidae and Blattidae would be impossible to identify here at present and it would be better for you to retain the Gryllidae until the publication of Chopard's monograph of the oriental members of this group'. He, however, offered to work through the Tettigoniidae and Mantidae though he thought that identification to the species would doubtless not be possible in every case. These two groups of insects were, therefore, sent to London and we are thankful to Dr. Ragge for their identification. Though no new species were recorded, the locality in many cases adds to the known range and is published here for the use of future workers. The species are arranged family-wise in the order now in use in the British Museum and are listed below with such remarks as add to what has been already recorded about them.

The following persons contributed to the collection of these insects:

(1) N. B. Kinnear, (2) C. McCann, (3) T. R. Bell, (4) P. F. Gomes, (5) E. Blatter, (6) S. H. Prater, (7) N. A. Baptista, (8) R. Newcome, (9) B. S. Carter, (10) D.G. Cameron, (11) F.P. Connor, (12) J. E. B. Hotson, (13) N. E. Standage, (14) A. G. Sheikh, (15) G. C. Shortridge, (16) C. E. Southon, (17) W. S. Millard, (18) C. H. Dracott, and (19) Saunders.

MANTIDS

The total number of species of Indian[1] Mantids according to Kirby's CATALOGUE in 1904 was 82. After its publication, as far as could be gathered from *Zoological Records* and other publications in the Library of the Society, about 55 additional Indian species have been described by various systematists in different journals making a total of 137 Indian species. Of these, 28 species from India and six more from neighbouring areas have been identified in our collection. The latter are listed only for record. More than half of these species, i.e. 19 species, belong to the family Mantidae which is the biggest family of this sub-order. The other families are represented by one to four species each, while we have no specimens of the family Orthoderidae.

Order : DICTYOPTERA

Sub-Order : MANTODAE

Family : AMORPHOSCELIDAE

1. **Amorphoscelis** sp. 1 ♂ : collected at Andheri (Bombay) in 1941. Two species of this genus have been recorded before, *A. annulicornis* Stal. in Assam (23)[2] and on the Indian mainland (17), and *A. indica* G.T. at Dehra Dun (17).

Family : EREMIAPHILIDAE

2. **Humbertiella** sp. 8 ♂♂, 7 ♀♀ : collected from Nasik, Bombay, Panchgani, Belgaum, Castle Rock, Gersoppa, and Mercara. Previous records : *H. indica* Sauss. in India, *H. septentrionum* Wood-Mason in Assam and Travancore (7), *H. ceylonica* Sauss. at Haldwani in the United Provinces, and Chinchchawatni in west Punjab (18), and *H. similis* G. T. in Nepal (5). *H. nigrospinosa* Sjo. is mentioned as Indian in *Ark. Zool.* **21**A, No. 32, 1930.

3. **Didymocorypha lanceolata** (Fab.) 1 ♂, 1 ♀, 1 nymph : collected in Karachi in 1903. This species was described as *D. ensifera* W.-M. (23) and is recorded from Tin Phar on the eastern flanks of the Rajmahal Hills, Bengal; Ceylon; and Kulu and Kangra in the NW. Himalayas. It is also known from Dehra Dun and Raipur in the Central Provinces (now Madhya Pradesh) (18).

4. **Dysaules himalayanus** Wood-Mason 2 ♂♂ : collected at Andheri (Bombay) in 1934 and Khandala in 1941. It was earlier descri-

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[1] Including Pakistan, but excluding Burma and Ceylon.
[2] The numbers within brackets indicate references at the end of this paper.

bed under the specific name *longicollis* and the range was given as the NW. Himalayas, Quetta, Kulu, Kangra, and Bengal (23). Other distribution shown is NW. India and Quetta (7), Dehra Dun and Haldwani in the United Provinces (18), and Rahtagaon and Hoshangabad in the Central Provinces (19).

Family: MANTIDAE

5. **Hierodula tenuidentata** Sauss. 3 ♂♂, 7 ♀♀: collected in Bombay and Panchgani in 1913, 1915, 1926, and 1932-33. This species has been collected in Malabar (India) and Borneo (7) under the name *Sphodromantis tenuidentata* Sauss.

6. **Hierodula coarctata** Sauss. 1 ♂: collected in Bombay in 1911. Its habitat has been recorded as India and Australia (7). Lefroy notes it as a familiar insect all over India (6).

7. **Hierodula unimaculata** (Oliver) 3 ♂♂: collected in Bombay-Salsette in 1910, 1926, and 1940. This species has been noted from Coromandel, Bombay; and from Tonkin (7) and Ceylon (21).

8. **Rhombodera woodmasoni** Werner 1 ♀: collected in 1916 at Nagarcoil, Madras State. Previously this was recorded at Nilambur, Kerala State (17).

9. **Mantis religiosa** L. Two specimens one collected in 1916 at Amara, Mesopotamia, the other in India (locality not stated). Its habitat is given as southern and central Europe, NW. Asia, and N. Africa (7).

10. **Acromantis** sp. Only one specimen, without any data. Previously a species of this genus, *A. oligoneura* Haan, has been recorded in India (7).

11. **Deiphobe infuscata** (Sauss.) 3 ♂♂, 1 ♀: collected in 1910 at Nagargali and Yellapur of Bombay Karnatak (now Mysore State). Previously recorded from Balaghat in the Central Provinces (now Madhya Pradesh) (18) and from Mussoorie and Dehra Dun in the United Provinces (19).

12. **Deiphobe indica** Giglio-Tos 1 ♂: collected at Nirwan (Kutch) 1935. Giglio-Tos in *Bull. Soc. ent. Ital.* **47** (1916) does not give its habitat. Species of this genus, however, have been noted all over India.

13. **Deiphobe** sp. 3 specimens: one collected at Kotagiri in the Nilgiris in 1916, another in Mesopotamia in 1916, and the third at Panchgani in 1932-33.

14. **Schizocephalus bicornis** (L.) 2 ♂♂: collected in 1915 and 1935 at Andheri (Bombay). Previously recorded from Africa, India, and China (7).

15. **Ambivia popa** Stal. 1 ♂, 2 ♀♀: collected in 1938 at Andheri and in the Naga Hills in 1941. Its habitat is given as India (7). Werner collected all his specimens from Dehra Dun (18 and 19).

16. **Phyllothelys westwoodi** (Wood-Mason) 1 ♀: collected in 1936 at Andheri (Bombay). Previously recorded from Naga Hills and Bhutan (7), and from Dehra Dun (17).

17. **Amantis** sp. Three specimens, two collected in 1934 at Andheri (Bombay) and one in Coorg (S. India) in 1916. Two species of this genus *A. subirina* G. T. from Assam and *A. indica* G. T. from India have been previously mentioned (5). Another species, *A. aliena* Beier, is recorded from Tenasserim (Burma) (2).

18. **Elmantis trincomaliae** (Sauss.) 1 ♂: collected at Deolali in 1915. It was previously noted only in Ceylon (5).

19. **Leptomentella** sp. There is only one specimen without any data. The generic name *Leptomantis* G. T. has been changed to *Leptomentella* (15), as the former was preoccupied. Two species of *Leptomantis* have been recorded in India before, *L. indica* G. T. in Assam (16) and *L. parva* Werner at Dehra Dun (18).

Family: HYMENOPODIDAE

20. **Ephistiasula pictipes** (Wood-Mason) 3 ♂♂: collected at Santa Cruz in 1912 and at Andheri (Bombay) in 1936. It was previously recorded from Dehra Dun (19).

21. **Creoboter gemmatus** (Stoll) 1 ♂, 3 ♀♀: collected in N. Kanara in 1928 and at Santa Cruz (Bombay) in 1912. Its habitat is recorded as America and Java (7). Species of *Creoboter* found in India are: *C. elongata* Beier in Sikkim, *C. arbana* Fab. in Dehra Dun (United Provinces) (10), and *C. apicalis* Sauss. in Mangalore (old Madras Presidency), and Bengal (17 and 19).

22. **Hymenopus coronatus** (Oliver) 1 ♀: collected at Chippendale, Simla, in 1909. Its habitat is given as Assam, Moluccas, and Sunda Islands under the name *H. bicornis* W.-M. (21). It is also noted from Sikkim, Java, and Sarawak (1).

23. **Evantissa pulchra** (Fab.) (= *Antissa pulchra* F.) 1 ♂, 1 ♀: collected in Karachi in 1905. The habitat of this species is recorded as: 'India, Ceylon. (Cape, *errore* ?)' (7). There is a reference by A. P. Mathew to this species in Trivandrum (9).

Family: TOXODERIDAE

24. **Paradanuria** sp. 2 ♂♂: one of these was collected at Bandra (Bombay) in 1912 and the other at Andheri (Bombay) in 1939. Its distribution is recorded as Indian sub-region of the Oriental region (24). The only Indian species, known as *P. orientalis* W.-M., was collected from Bangalore, Mysore (24).

Family: VATIDAE

25. **Aethalochroa ashmoliana** (Westwood) 4 ♂♂, 1 ♀: two collected in Bombay once in 1912 and at Andheri again in 1937 and three at Panchgani in 1932. It is recorded from Bombay and N. India (7). It has also been recorded from Madras and Ceylon (20) and from Bengal, United Provinces, etc. (16, 21).

Family: EMPUSIDAE

26. **Gongylus gongylodes** (L.) 2 ♂♂, 1 ♀: one collected in Thana Hills in 1928, the second at Mt. Abu in 1940, and the third at Bhyander in Thana District in 1937. Its habitat is given as India and Ceylon (7).

27. **Empusa pauperata** (Fab.) 1 ♂: collected at Nasik in 1914. Its habitat is given as India and Ceylon (7).

28. **Blepharopsis mendica** (Fab.) 2 ♂♂, 1 ♀: two collected in Karachi in 1905 and 1907 and the third at Amara, Mesopotamia, in 1916. Its habitat is known to be N. Africa and west Asia (7 and 12).

Along with the 28 species enumerated above, there are six more collected from the neighbouring countries. They are:

EREMIAPHILIDAE

(1) **Eremiaphila cerisyi** Lef.: collected at Muscat in 1918

MANTIDAE

(2) **Rhombodera valida** Burm.: collected at Azahar, Malacca, in 1913

(3) **Fischeria baetica** Ramb. (damaged to some extent): collected at Mesopotamia in 1916

(4) **Deroplatys truncata** (Guerin): collected at Singapore in 1913

(5) **Phyllocrania paradoxa** Burm.: collected in Nairobi (Kenya).

EMPUSIDAE

(6) **Empusa fasciata** Brull.: collected at Abadeh (Persia) in 1916.

TETTIGONIDS — LONGHORNED GRASSHOPPERS

Great strides have been made in the study of Tettigoniidae in the world but India has remained far behind. Kirby (8) mentioned 3161 species in his catalogue of Tettigoniidae of the world; of these only 150, less than 5% of the total, were Indian. Since then the total number has risen to more than 4000, while only about 29 new species have been added to the family in India, raising our total to 179. We have in our collection only a few, as catalogued below. All of them were identified by B. P. Uvarov. They are also arranged below family-wise as in the case of Mantids. The non-Indian species have been listed only for record.

Order ORTHOPTERA

Family: TETTIGONIIDAE — LOCUSTIDAE

Sub-family: CONOCEPHALLINAE

1. **Conocephallus indicus** Redt. Three specimens: collected one each at Belgaum in 1910, Berars in 1913, and Panchgani in 1932. Its habitat is recorded as India, China, Java, etc. (8).

Sub-family: PSEUDOPHYLLINAE

2. **Morsimus carinatus** Walk. Two specimens: collected in Bombay in 1918. Its habitat is mentioned as India and Ceylon (8). Uvarov has recorded its habitat as Bombay and criticises Kirby's nomenclature in this regard (13). He writes: 'Kirby in his CATALOGUE has quite incorrectly regarded *carinatus* Walk. as distinct from *curvifrons* Walk. since the types of both species are undoubtedly conspecific; on the other hand he was quite wrong in synonymising *A. gracile* Walk. and *A. oculatum* Sauss. & Pict. with *M. carinatus*.' The generic name *Morsimus* was changed recently to *Paramorsimus* (4).

3. **Sathrophyllia rugosa** Linn. Eight specimens: collected in Andheri (1908), Coorg (1920), Nasik (1938), and Deolali (1940). Its habitat is mentioned as India and Ceylon (8).

4. **Sanna imperialis** Wh. Four specimens: collected in Sikkim in 1912-1914. Its habitat is recorded as N. India (8).

5. **Callimenellus opacus** Br. Two specimens: collected at Khandala in 1940. The habitat of this species is recorded as Tenasserim (8). Another species of this genus, *C. apterus* Beier, however, is recorded as Indian (3).

Sub-family : MECOPODINAE

6. **Mecopoda elongata** Linn. Eight specimens : collected in Bombay in 1936 and in Goa in 1938. Its habitat is recorded as China, Japan, India, Malacca, Malaya, Moluccas, and Australia (8). This is an extremely common grasshopper round about Bombay, appearing every year at the end of October and hovering round the street lights at nightfall.

Sub-family : PHANEROPTERINAE

7. **Ducetia japonica** Stall. Five specimens : collected at Nasik in 1913 and Bombay in 1938 and 1939. There is one specimen without any data and identified by B. P. Uvarov as *Ducetia thymifolia* Fab. which is a synonym. Its habitat is known as India, Ceylon, Japan, Java, Borneo, the Philippines, Cambodia, and Australia (8).

8. **Trigonocorypha unicolor** Stall. Eight specimens : collected in Bombay in 1940. India and Java are mentioned as its habitat (8).

9. **Elimaea securigera** Brunn. Three specimens : collected at Madurai in 1917 and Bombay in 1938. Its habitat as noted are N. India and Ceylon (8).

Two more species were collected from outside India. Both belong to the sub-family Decticinae. They are :

(1) **Decticus albifrons** Fab. : collected in Mesopotamia in 1916.

(2) **Decticus assimilis** Fieb. : collected at Bandamir in 1920.

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On the Marine Fauna of the Gulf of Kutch

PART III—PELECYPODS

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[*Continued from Vol.* **58** (2) : 494]

(*With fifteen plates*)

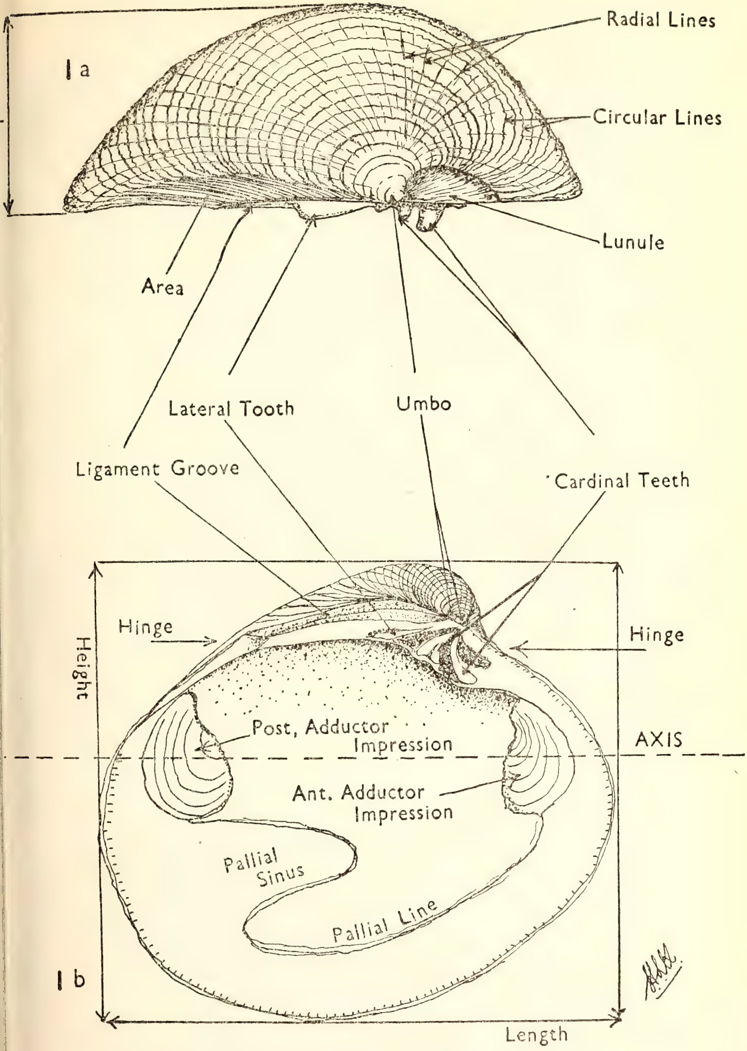
I. INTRODUCTION

Hornell in 1916 gave a general account of the marine fauna of Okha Mandal. In 1957 Gideon *et al.* published a preliminary survey of marine fauna of the Gulf of Kutch (Part I), followed by Menon *et al.* in 1961 with an account of the Gastropods (Part II). Here I present an account of the Pelecypods (Part III).

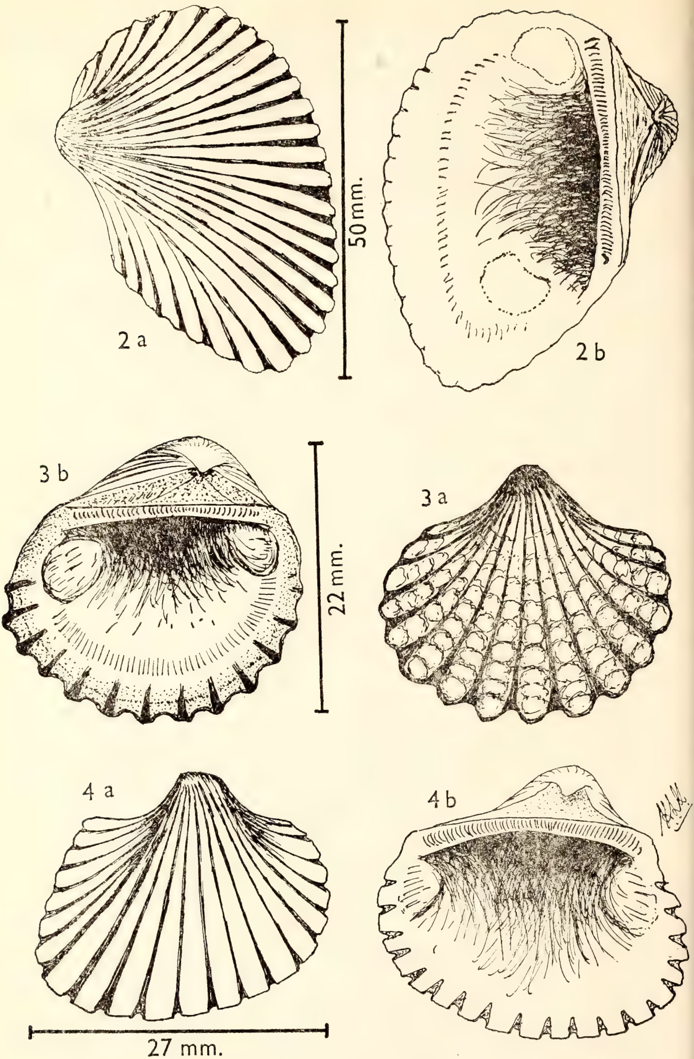
The present account gives short descriptions of all the species of bivalves collected by me and my colleagues from the Gulf of Kutch. I hope that the account will be useful to shore collectors and that the re-descriptions of known species along with their diagrams will be useful to other workers.

II. AREAS SURVEYED

Shells were mainly collected from the different localities of Pirotan Island as well as Port Okha, Belarpur Bay, Hanuman Dandi, and Veraval (for map, see Gideon *et al.* 1957). Collections were made at low tide in the autumn months from 1956 till 1963, from the intertidal zones as well as from places with knee-deep water at low tide. Live specimens were narcotised with chloral hydrate solution (in sea-water) and then preserved in either 5% formalin or 70% alcohol. However, most of the collection consists of dry shells.


1 a
Radial Lines
Circular Lines
Lunule
Area
Lateral Tooth
Umbo
Ligament Groove
Cardinal Teeth
Hinge
Hinge
Height
Post, Adductor Impression
AXIS
Ant. Adductor Impression
Pallial Sinus
Pallial Line
1 b
Length

Salient features of a Pelecypod Shell (one valve)
Fig. 1a. top view (schematic) ; Fig. 1b. lateral view (from inside)


2 a
50mm.
2 b
3 b
22mm.
3 a
4 a
4 b
27 mm.

Figs. 2a, 2b. *Arca gubernaculum*: outer and inner views respectively;
Figs. 3a, 3b. *Arca granosa* : outer and inner views respectively;
Figs. 4a, 4b. *Arca rhombea* : outer and inner views respectively

III. DESCRIPTION OF A TYPICAL PELECYPOD SHELL

The shells of pelecypods consist of two units or *valves*, which mostly envelop the soft viscera and are joined to each other by a *ligament* in the dorsal aspect of the valves, the *hinge* (Plate I, figs. 1a and 1b). Upon the outer aspect of the hinge there is a pointed and raised area the *umbo* or apex. Besides the ligament in the area of the hinge, there are some *teeth*. The teeth directly under the umbo are called *cardinal teeth*, the outer ones the *lateral teeth*. The umbo is directed forwards and the ligament is situated posterior to the umbo. Inside the valves there are two prominent impressions, *the scars of the anterior and the posterior adductor muscles*. A *pallial line* connects these scars. Along this line the mantle is attached to the valves. In many species, beneath the posterior adductor impression the pallial line forms a deep bay, the *pallial sinus*. Siphons when retracted are housed within this sinus. The pallial sinus is always associated with the posterior adductor scar, whereas the face of the umbo is always directed forwards. Thus it is easy to determine the face and the side of a valve. Except in the Donacidae, the anterior sides of most species are shorter than the posterior sides. The *lunule* and the *area* are the two somewhat flattened areas, respectively, in the front and the aft of the umbo. Most shells when fresh are covered with a brownish horny envelope, the *periostracum*, which on drying tends to peel off.

IV. MEASUREMENTS

The following measurements have been used in this paper (Plate I):

1. the *axis* of the valve: the line connecting the centres of the adductor impressions;
2. the *length* of the valve: the longest distance measured along a line parallel to the axis;
3. the *height* of the valve: the maximum width measured along a line at right angles to the axis;
4. the *depth* of the valve: half of the maximum thickness when both the valves are tightly fitted and closed together;
5. the *weight* of the valve: dry weight of one valve.

However, for *Ostrea* and *Pinctada* the hinge was taken as the axis, and in the case of *Placenta* only the diameter was measured. The measurements 2 to 4 were taken with a slide calliper fitted with a vernier scale and the measurement 5 with an automatic air-damped balance. For certain recordings (see *Meretrix*: General Discussion) a travelling microscope was used.

The actual measurements of the shells drawn as well as the range of measurements found in each species (in our collection) have been given. All the measurements along with the number of the specimens studied are presented in a tabular form (Table V).

All the diagrams were drawn by the author except Nos. 36a, 37, 40, 48, 53b, 60b, and 64a, which were stippled by Professor A. K. Datta Gupta.

V. DESCRIPTION OF SPECIES

Generally Thiele's classification (1935), as followed by Satyamurti (1956), has been adopted here.

Family ARCIDAE (Ark shells)

Members of this family are characterized by the possession of a straight hinge beset with numerous teeth. The family consists of only two genera *Arca* and *Barbatia*.

Genus **Arca** Linné

Eleven species of *Arca* have been recorded from the Gulf of Kutch some of which are not recorded from Krusadai (Satyamurti 1956). *Arca granosa*, the so-called Common Indian *Arca*, is not very common here; instead *Arca gubernaculum* is more common.

1. **Arca gubernaculum** Reeve. Plate II, figs. 2a, 2b

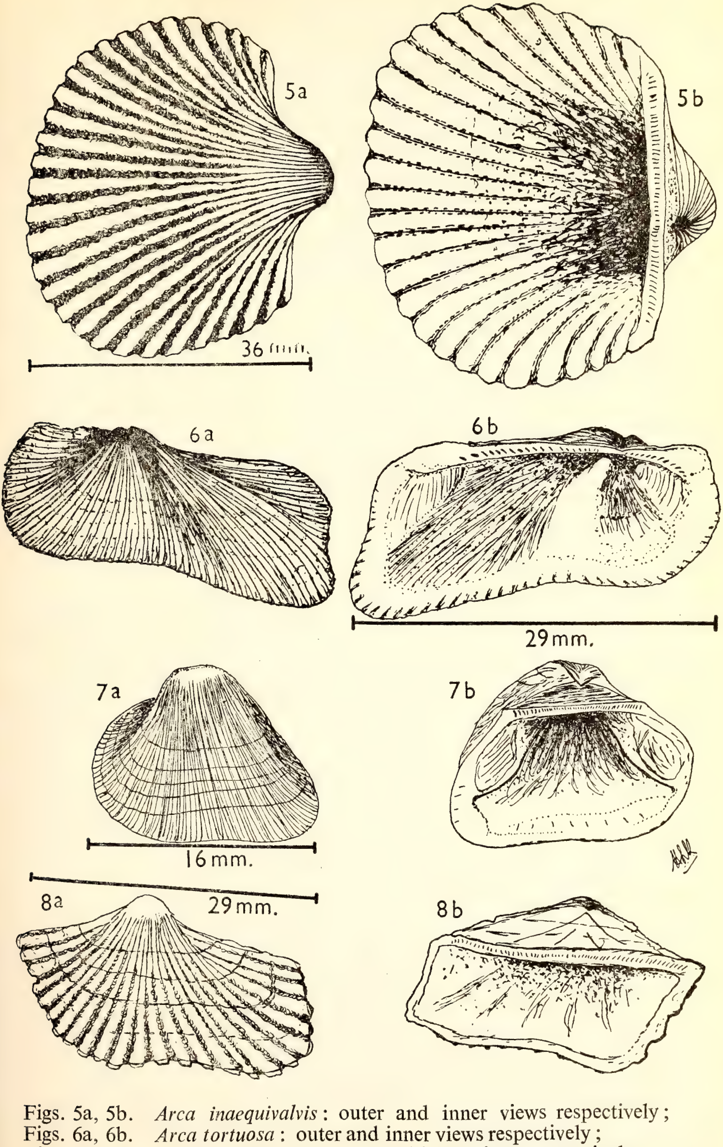
Valves thick, heavy, and elongately ovate; postero-ventral angle acute; antero-ventral angle broadly obtuse; outer surface covered with strong broad ribs and deep interstices.

Hanuman Dandi, Pirotan Island.

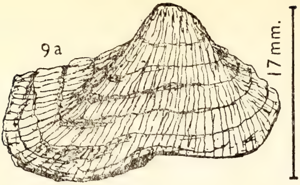
2. **Arca granosa** Lamarck. Plate II, figs. 3a, 3b

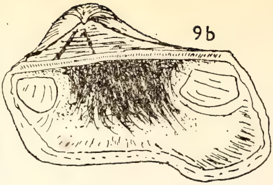
Rare. Only one left valve was found. Shell very thick with strong ribs marked in the outer side with tubercle-like grains formed by concentric ridges. In young shells the ribs are as broad as the interstices, which however become broader than the ribs in the larger shells (obtained from other parts of India). According to Hornell (1951) this species is widely distributed in backwaters and estuaries. The outer surface of the valve is tinted bluish grey.

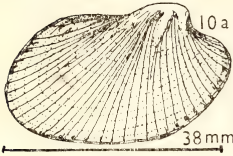
Pirotan Island.

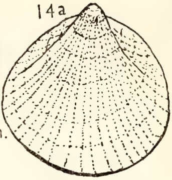

5a
5b
36 mm.
6a
6b
29mm.
7a
7b
16mm.
8a
29mm.
8b

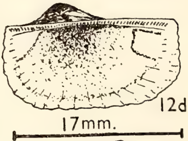
Figs. 5a, 5b. *Arca inaequivalvis*: outer and inner views respectively;
Figs. 6a, 6b. *Arca tortuosa*: outer and inner views respectively;
Figs. 7a, 7b. *Arca symmetrica*: outer and inner views respectively;
Figs. 8a, 8b. *Arca navicularis*: outer and inner views respectively

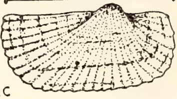

9a

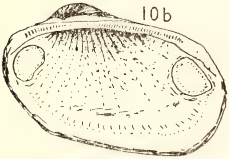

9b

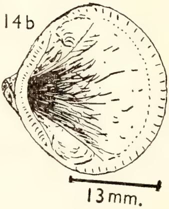

10a

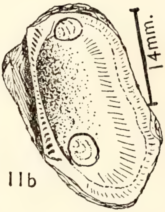

14a

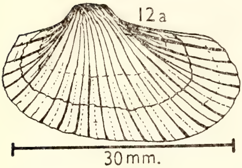

12d


12c


10b


14b


11b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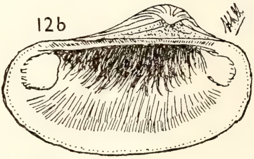
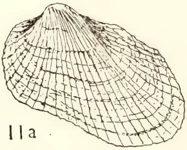

12b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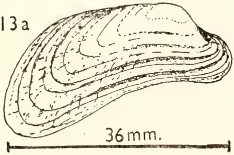
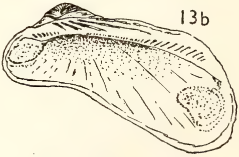

13a


13b

Figs. 9a, 9b. *Arca avellana*: outer and inner views respectively; Figs. 10a, 10b. *Arca fusca*: outer and inner views respectively; Figs. 11a, 11b. *Arca complanata*: outer and inner views respectively; Figs. 12a, 12b. *Arca bistrigata* (grown up shell): outer and inner views respectively; Figs. 12c, 12d. *Arca bistrigata* (young shell): outer and inner views respectively; Figs. 13a, 13b *Barbatia obliquata*: outer and inner views respectively; Figs. 14a, 14b. *Glycimeris taylori*: outer and inner views respectively

3. **Arca rhombea** Born. Plate II, figs. 4a, 4b

Valve rhomboidal, very thick, with prominently raised umbones and well-angulated margins. The length and the height are very nearly equal.

Pirotan Island.

4. **Arca inaequivalvis** Bruguiére. Plate III, figs. 5a, 5b

Valve inequivalve (i.e. the umbo is placed in front of the middle), and tinted light yellowish brown; ribs distinct and shallow and, owing to the thinness of the valves, show up on the inner surface too. Hinge margins angular but the outer margins broadly rounded.

Pirotan Island.

5. **Arca tortuosa** Linné. Plate III, figs. 6a, 6b

Shell thin and is easily recognizable by its remarkably tortuous nature. Axis of the hinge and axis of the outer rim twisted against each other at an angle of 30 degrees or so; outer surface covered with fine ribs. There may also be a few but distinct concentric lines of growth. Shell whitish with a tinge of rust-brown near the umbones. *Arca tortuosa* is so twisted that it is difficult to measure the depth of the shell. Rare in the interior of the Gulf, but very common at Veraval.

Veraval.

6. **Arca symmetrica** Reeve. Plate III, figs. 7a, 7b

Small; mostly found cast up alive on the beach by the waves, with valves tightly closed. Hinge axis and outer axis parallel to each other; posterior margin obliquely truncated and anterior margin rounded; umbones raised and directed inwards; outer surface covered with fine radiating ribs crossed by infrequent concentric rings. The surface of most living shells is covered with a thin brownish periostracum. A very common shell at Veraval.

Veraval.

7. **Arca navicularis** Bruguiére. Plate III, figs. 8a, 8b

Shell stout; yellowish with inside face rather like a parallelogram; ventral margin somewhat incurved and outer margin more or less truncate; umbones set widely apart, the area between them broad and diamond-shaped with a few grooves radiating from the umbones to the hinge. Ribs distinct but shallow and become progressively faint towards the umbones. There are a few concentric growth lines as well. This species is uncommon and is not listed by Hornell (1951), Gravely (1941), and Satyamurti (1956).

Pirotan Island.

8. **Arca avellana** Lamarck. Plate IV, figs. 9a, 9b

Shell long and broad with angulated hinge corners; outer margin uneven with a depression in the middle; umbones raised and directed inwards with a broad diamond-shaped space in between them; a strong keel from the umbone to the posterior corner of the valve. Surface covered with fine radiating lines crossed by a few concentric rings. The outer surface is finely tuberculate and there are brownish patches especially at the posterior corner. Very common in Veraval.

Veraval.

9. **Arca fusca** Bruguiére. Plate IV, figs. 10a, 10b

The shell is fairly common and can be easily recognized by the white interior, the dark exterior surfaces and three white streaks radiating from the umbones, which are placed almost at the anterior end of the hinge line. All the angles are rounded off and the fine concentric rings intersect the radiating ribs so regularly that the ribs look like beaded lines. The outer hinge teeth are directed somewhat outwards. In the inside of fresh specimens one can discern fine impressions of radiating lines fanning out from the umbones up to the pallial line.

Pirotan Island.

10. **Arca complanata** Chemnitz. Plate IV, figs. 11a, 11b

Shell ovately oblong; when fresh the outside is brownish white and traversed by fine radiating lines which split up into two in the periphery. Umbones placed forwards; hinge margin angulated; lower margin of the valve somewhat indented in the middle; area between the umbones brownish and marked with fine wide V-shaped grooves the apices of which are directed towards the umbones.

Pirotan Island.

11. **Arca bistrigata** Dunker. Plate IV, figs. 12a-12d

Shell longer than high with corners rounded off; umbones placed rather anteriorly and approximate each other closely. Ribs shallow but distinct and split into two near the periphery. Faint but close concentric lines make the ribs appear thinly beaded. Valve light yellowish brown in colour. (Figs. 12a, 12b)

Very young shells of this species differ conspicuously from the adult shell. A young shell (for measurements, see Table V) is characterized by the possession of a hinge line longer than the ventral margin and the hinge corners are angulated while the other corners are rounded off. The body is light yellow but the umbo has a deep yellow radiating band. (Figs. 12c, 12d)

Veraval.

Genus **Barbatia** Gray

Hinge teeth are arranged obliquely appearing to radiate outwards from the axis of the valve. End teeth of the hinge line are prominent, but teeth in the middle of the hinge (near the umbo) are extremely small.

12. **Barbatia obliquata** Gray. Plate IV, figs. 13a, 13b

Shell smooth, elongated, bean-shaped with anterior end narrower than the posterior; antero-ventral surface somewhat indented giving the shell an oblique shape with the radial lines on outer surface very faint and the concentric growth rings very deep (a feature not seen in other species of Arcidae). Shell white with a tinge of dark brown on the posterior side of the umbo. Fresh shells covered with a thin dark periostracum which peels off on drying. The impression of the pallial line is faint although the adductor impressions are prominent.

Pirotan Island.

Family GLYCIMERIDAE

The hinge has a curved margin. The median teeth upon the hinge are either absent or very reduced and the outer teeth are oblique.

Genus **Glycimeris** Da Costa

13. **Glycimeris taylori** (Angas). Plate IV, figs. 14a, 14b

The shell can be easily recognized by the bent hinge line which looks like a very wide V, white colour, and almost round outline. From the umbo which is in the centre of the V, faint and smooth lines radiate out. In the inner side there are two shallow but distinct keels which radiate from the umbo and run by the outer sides of the adductor scars. The shell is smooth with specks of brown on the rim.

Pirotan Island.

Family MYTILIDAE (Mussels and Date shells)

In this family the shell is extremely inequilateral and the anterior adductor is feebly developed and in some cases altogether lacking.

Genus **Mytilus** Linné

The shells are acuminate with terminal umbones.

14. **Mytilus viridis** Linné. Plate V, figs. 15a, 15b

Shell brownish green outside with a thin pearly layer inside. Broadly conical in outline with the pointed end denoting the anterior end and the base the posterior end. When alive can be easily recognized by its brilliant green colour (hence also known as Green Mussel). Used as food in some parts of India.

Pirotan Island.

Genus **Modiolus** Lamarck

The anterior edge is rather blunt and the umbones are sub-terminal (i.e. somewhat behind the terminus). There is a somewhat shallow keel running from the umbo to the ventral hind corner of the valve.

15. **Modiolus metcalfei** (Henley). Plate V, figs. 16a, 16b

Shell moderately light with a thin dark brown periostracum; inside pearly but the thinness of the shell and the presence of the periostracum give it a bluish tinge; ventral margin slightly incurved; aft of the shell covered with fine hairy growth and fine and close concentric markings upon the uncovered portion of the periostracum. According to Horneil (1951) such hairy growths are noticed in a few other species of *Modiolus* and, in Gulf of Mannar, the hairy growth of *Modiolus barbatus* forms a carpet of tangled mass on the sea-bottom.

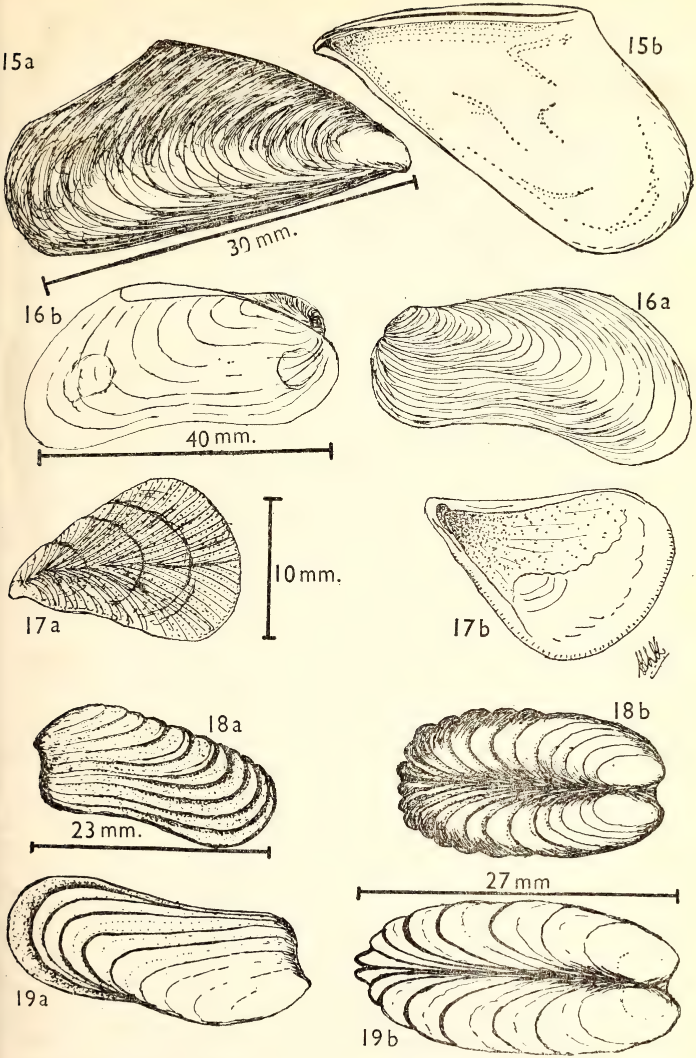
Pirotan Island.

Genus **Septifer** Récluz

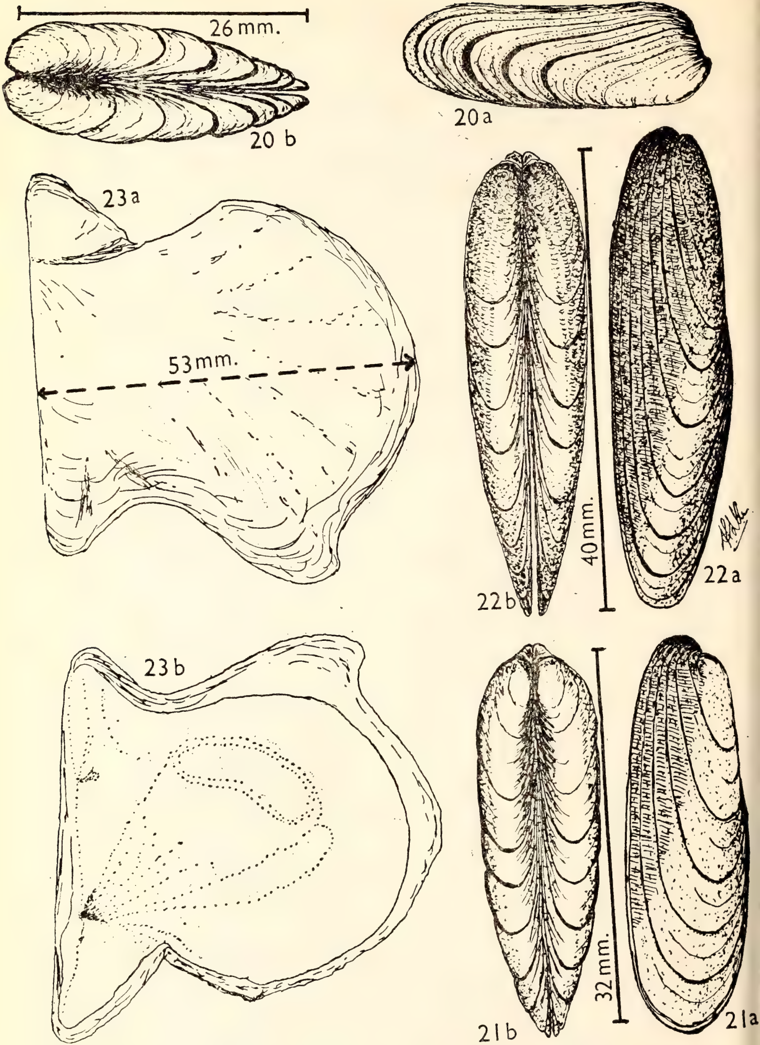
Members of this genus are characterized by the presence of a terminal umbo and a calcareous plate in the anterior internal angle, to which the adductor muscle is attached.

16. **Septifer bilocularis** (Linné). Plate V, figs. 17a, 17b

Shell broadly triangular with outer surface orange in colour and inside white. The orange hue is somewhat faded in the anterior end as well as the antero-ventral surface, which is also somewhat flattened. Internally the anterior angle has a shallow place for the attachment of the adductor muscle. The surface is marked with beautiful radial


15a
15b
30 mm.
16b
16a
40 mm.
17a
10 mm.
17b
18a
18b
23 mm.
27 mm
19a
19b

Figs. 15a, 15b. *Mytilus viridis* : outer and inner views respectively; Figs. 16a, 16b. *Modiolus metcalfei* : outer and inner views respectively; Figs. 17a, 17b. *Septifer bilocularis* : outer and inner views respectively; Figs. 18a, 18b. *Lithophaga cinnamomea* : lateral and dorsal views respectively; Figs. 19a, 19b. *Lithophaga* sp. (near *cinnamomea*) : lateral and dorsal views respectively


26 mm.
20 b
20 a
23 a
53 mm.
22 b
40 mm.
22 a
23 b
21 b
32 mm.
21 a

Figs. 20a, 20b. *Lithophaga* sp. (near *teres*) : lateral and dorsal views respectively ; Figs. 21a, 21b. *Lithophaga teres* : lateral and dorsal views respectively ; Figs. 22a, 22b. *Lithophaga nigra* : lateral and dorsal views respectively ; Figs. 23a, 23b. *Pinctada vulgaris* : outer and inner views respectively lines which spread out like a fan from an approximate median antero-posterior axis. According to Satyamurti (1956) *Septifer bilocularis* is widely distributed in the Indo-Pacific region. However, in the Gulf of Kutch this species is rare.

Veraval.

Genus **Lithophaga** (Bolten) Röding

(syn. *Lithodomus*)

These shells are commonly known as 'Date shells' as many of them resemble date seeds, being cylindrical or sub-cylindrical in shape and light or deep chestnut-brown in colour. The umbo is terminal or just sub-terminal. When fresh the shells are covered with a thin pellicle of periostracum which on drying peels off. The sculpturing upon the periostracum is of taxonomic value. Hence Lithophagans should be preserved in 5% formalin or 70% alcohol.

Lithophaga of our collection fall into two distinct categories. The first group is characterized by ultra-terminal umbones and lack of perpendicular striations upon the ventral side of the valves whereas, in the second group, the umbone is infra-terminal (i.e. sub-terminal) and the perpendicular striations are present upon the ventral side of the valve. Satyamurti (1956) mentions only *Lithophaga* of the second type. It may be mentioned, however, that the fine striations are easy to see when the periostracum is intact.

17. **Lithophaga cinnamomea** (Lamarck). Plate V, figs. 18a, 18b

Shell easily recognized by its rather extraordinarily short and inflated nature (length : height ratio = 2·2 and height : depth ratio = 1·6). Ventral edge definitely incurved, giving a somewhat bean-like side view; umbones ultra-terminal, jutting out in such a way that the anterior end appears truncated. Owing to its shortness and great depth the shell has a rather gorged appearance. The species is represented by a single shell with the periostracum mostly peeled off. There are deep and strongly pronounced concentric rings upon the valves. Perpendicular striations are absent in the remnants of the periostracum.

Pirotan Island.

18. **Lithophaga** sp. (near **cinnamomea**)[1]. Plate V, figs. 19a, 19b

This species of which I have only one specimen resembles *cinnamomea* in shape, except that it is longer and less deep. The umbones are ultra-terminal and in lateral view the shell looks somewhat arched. Unfortunately the periostracum has peeled and the remnants of it do not show the presence of any cross-striation. The hind end of this shell tapers off and does not present the rotund look of *L. cinnamomea* when viewed from above. Concentric rings are present. These rings are more pronounced towards the posterior than the anterior end.

Pirotan Island.

19. **Lithophaga** sp. (near **teres**). Plate VI, figs. 20a, 20b

The shell appears sleeker than the preceding one and its posterior end tapers off gradually. Umbo ultra-terminal. This specimen has an intact chocolate-brown periostracum without cross-striations. Regular concentric rings occur and, towards the hind end, are deep and distinct. In the middle of the hinge line there is a faint but distinct angulation.

Pirotan Island.

20. **Lithophaga teres** (Philippi). Plate VI, figs. 21a, 21b

Shell lanceolate, light brown, with infra-terminal (i.e. sub-terminal) umbones, and numerous fine perpendicular cross-striations on the antero-ventral surface. Concentric rings present but not so deep as in preceding ones. Distinct angulation in the middle of hinge line.

Pirotan Island.

21. **Lithophaga nigra** (d' Orbigny). Plate VI, figs. 22a, 22b

Shell dark chocolate-brown and more elongated than *teres*. Cross-striations deeper but concentric rings fainter than in *teres*; umbo infra-terminal; sharp and distinct angulation almost in middle of dorsal hinge line. Of the many specimens of this species in our collection the largest, a broken one, is 73 mm. long and 18 mm. high.

Pirotan Island.

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[1] Dr. S. T. Satyamurti, Superintendent, Government Museum, Madras, has tentatively identified serial No 18 as near *L. cinnamomea* and 19 as near *L. teres*. However, as these shells are not represented in his collection, he could not be very certain about their identification (1964). Certain aspects of the external morphology of Lithophagan shells have been further discussed in the section 'General Discussion'.

Family PTERIIDAE (Pearl Oysters and Wing Shells)

This family includes such well-known forms as pearl-oysters (*Pinctada* sp.) and wing-shells (*Pteria* sp.). The hinge is toothless and straight. The left valve is more inflated than the right. The outer surface tends to be scaly.

Genus **Pinctada** (Bolten) Röding

The shell is nearly an equivalve and the height and the length are almost the same.

22. **Pinctada vulgaris** (Schumacher). Plate VI, figs. 23a, 23b

Shell broadly squarish with a tubercle-like ridge at about $\frac{1}{4}$th distance from the anterior end; ventral surface laminated and greenish brown. The laminae indicate the lines of growth. Common in the low tide areas of Pirotan Island under about 1 foot of water. Inside, this shell has a pearly lustre.

Pirotan Island.

Family PINNIDAE (Feather Shells)

The family is well represented at Pirotan Island and specimens are frequently found in the low-tide areas in 6 to 12 inches of water, with $\frac{3}{4}$th of their anterior end sunk vertically in sand. The shells are like large triangular fans, with the anterior end pointed. Hinge straight and long, byssus well developed; anterior adductor muscle small and situated almost at the tip; posterior adductor muscle large and situated near the middle of the hinge line.

Genus **Pinna** Linné

The characters are same as those of the family.

23. **Pinna bicolor** Gmelin. Plate VII, figs. 24a, 24b

Very common in Pirotan Island. Shell comparatively light and covered with thin light brown periostracum which, in young specimens, scaly in appearance. The scales are raised in medial lines. These shells are characterized by the presence of some distinct, wide blackish brown radial shades. Internally, the moieties of the nacreous layer are separated by a somewhat wide tract in the middle.

Pirotan Island.

24. **Pinna atropurpurea** Sowerby. Plate VII, figs. 25a, 25b

Shell heavier and darker than that of *bicolor*. Radial shades either absent or indistinct. Dark blotches scattered all over the shell, especially towards ventral end; inside of ventral end covered with thin non-glossy white layer. The two moieties of the nacreous layer are separated by a narrow line in the middle. The periostracum is a bit thick. This species is less common than *P. bicolor* but frequently attains a larger size than it.

Pirotan Island.

Family PECTINIDAE (Scallops)

These are characterized by a rather long hinge, lack of true hinge-teeth, and a medial ligament which is often placed in a triangular groove upon the hinge. Radial ribs or folds are common.

Genus **Pecten** (Klein) Osbeck

Valves roundish with a tendency to flatten out; auricles (the ear-like lobes upon the ends of hinge line) well developed.

25. **Pecten tranquebaricus** (Gmelin). Plate VII, figs. 26a, 26b

A beautiful shell with some broad reddish brown bands. Radial ribs well developed and anterior auricle longer than posterior. Almost equivalve (i.e. the umbo is in the middle of the hinge line).

Pirotan Island.

26. **Pecten distans** Lamarck. Plate VII, figs. 27a, 27b

Shell flat, nearly equivalve, and auricles prominent. There are 11 ribs, both ribs and grooves being equally wide. Ribs finely cross-ridged and regular brown spots on ribs and furrows.

Veraval.

27. **Pecten crassicostatus** Sowerby. Plate VIII, figs. 28a, 28b

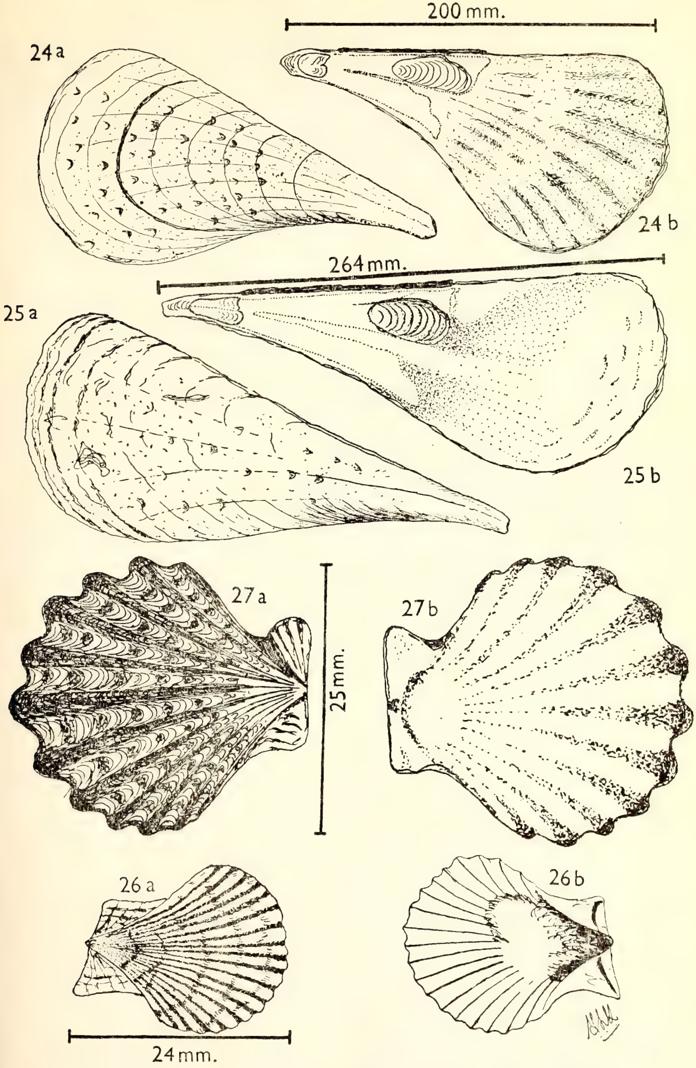
Shell an equivalve, but anterior auricle longer than posterior. Posterior angle short but wide and forming an obtuse angle with rim. Upon anterior rim, within angle formed by jutting out of anterior auricle, 4 to 5 fine denticles. Surface of shell rather inflated and smooth, and about 28 main ribs and interstices. Towards periphery, main ribs have faint medial furrows which make them look composite. Upon the surface there are light reddish brown circular patches.

Pirotan Island.

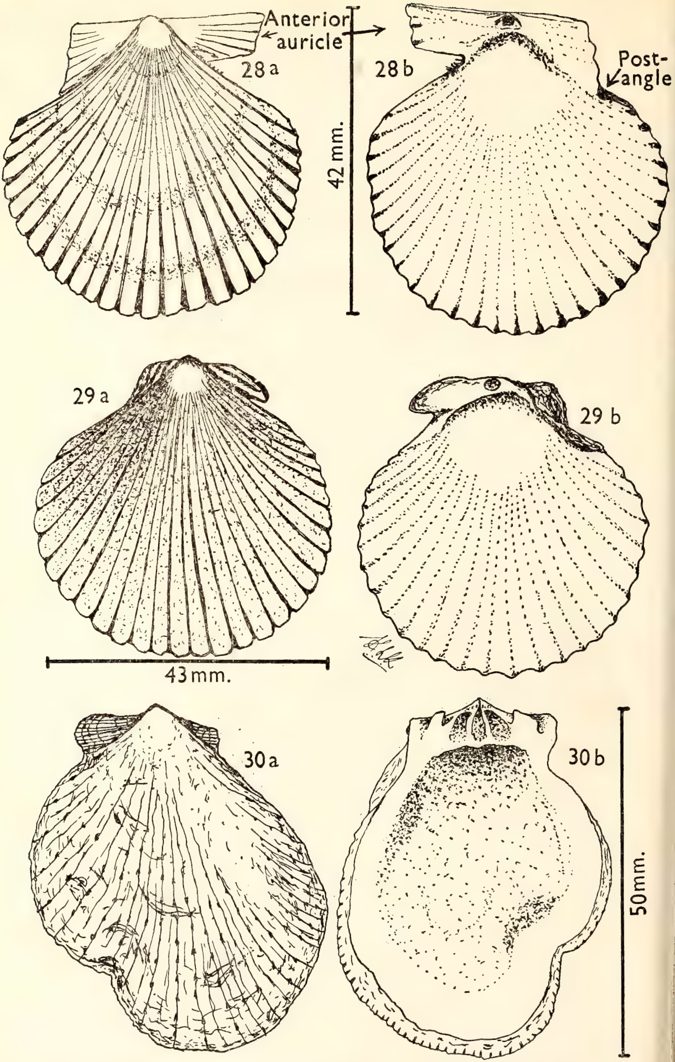
28. **Pecten pyxidatus** (Born). Plate VIII, figs. 29a, 29b

Shell dark with smooth surface but deep radial grooves and wide interstices. General colour dark green, very nearly like slate, and outline almost round. The ribs show up internally as well.

Pirotan Island.


200 mm.
24 a
24 b
264 mm.
25 a
25 b
27 a
25 mm.
27 b
26 a
26 b
24 mm.

Figs. 24a, 24b. *Pinna bicolor* : outer and inner views respectively ; Figs. 25a, 25b. *Pinna atropurpurea* : outer and inner views respectively ; Figs. 26a, 26b. *Pecten tranquebaricus* : outer and inner views respectively ; Figs. 27a, 27b. *Pecten distans* : outer and inner views respectively


Anterior
auricle
28a
42 mm.
28b
Post-
angle
29a
29b
43mm.
30a
30b
50mm.

Figs. 28a, 28b. *Pecten crassicostatus* : outer and inner views respectively ; Figs. 29a, 29b. *Pecten pyxidatus* : outer and inner views respectively ; Figs. 30a, 30b. *Spondylus layardi* : outer and inner views respectively

Genus **Spondylus** Linné. (Thorny Oysters)

The surface of the free valve has rows of short spiny processes while the corresponding surface of the attached valve has rough concentric laminations. The outside is bright pink and the hinge margins are well angulated.

29. **Spondylus layardi** Reeve. Plate VIII, figs. 30a, 30b

Shell rather thick and somewhat irregular. Mostly found attached to some object with the help of the right valve. The left valve, which is free, bears upon its hinge two strong lateral teeth and three medial depressions. Rim of inside of valve has pink border; rest of inside white. On top centre of hinge, there is a triangular impression for the reception of the ligament.

Pirotan Island.

Family LIMIDAE

Members of this family usually have pale coloured ovoidal shells. The ligamentary area is triangular. The teeth may be absent. The radial ribs are characterized by nodulations or transverse scales.

Genus **Lima** Chemnitz

Characters same as above.

30. **Lima lima** (Linné). Plate IX, figs. 31a, 31b

Valve somewhat oval. Many radial ribs, some stronger than the rest. Auricles short but definite. Fine dark-brown streaks radiate from the umbo. Only one rather worn out valve.

Veraval.

Family ANOMIIDAE (Window-Pane Oysters)

This family consists of shells which have rounded but unequal and translucent valves.

Genus **Anomia** Linné

The byssus passes through a deep cleft (in young shells) or a circular perforation (in adult shells) in the right valve. The inner surface is pearly.

31. **Anomia achaeus** Gray. Plate XI, figs. 32a, 32b

Form rather peculiar. Colour translucent reddish brown and external surface somewhat crumpled. Ribs radial but discontinuous, looking more like mountains radiating from the umbo than continuous ribs. Inside smooth and glossy but, in the centre, a large rhomboidal area with four impressions (see figure) which might owe their origin to the adductor muscles. The valve is thin but very hard and seems to be made of only nacre (of reddish hue). Only one valve was found (left).

Pirotan Island.

NOTE. This valve has certain features in common with *Plicatula australis* Lamarck (Pectinidae), as described by Satyamurti (1956). However, a pair of strong hinge teeth found in *australis* are totally absent from our specimen.

Genus **Placenta** Retzius

These are the true window-pane oysters and have nearly equal valves. The valves are almost flat and the outer surfaces are totally finely laminated.

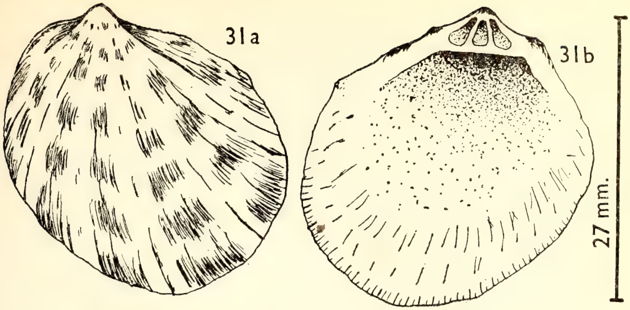
32. **Placenta placenta** (Linné). Plate IX, figs. 33a, 33b

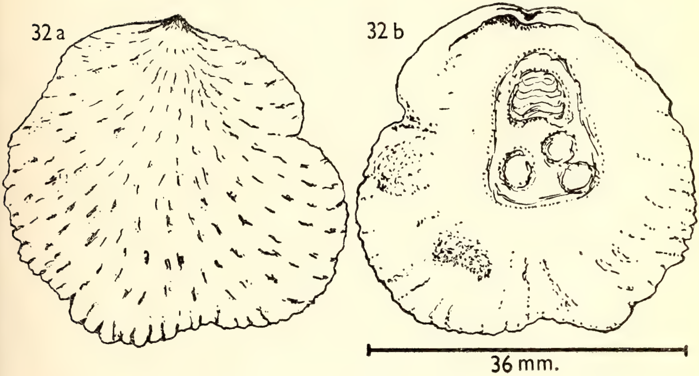
Live specimens look like slightly oval discs. Actual dimensions of this species are difficult to obtain as the rims are extremely thin and brittle. One valve a little convex and the other flat, if not a little concave. General hue translucent and faint pearly pink. The inside of the convex valve has two deep grooves which radiate from the umbo, one of them shorter and more curved than the other (in this specimen 14·5 mm. and 21·4 mm. respectively). Corresponding to these grooves, two teeth on the other valve. Umbo faint and central. Adductor impression more or less central, large and roundish. The inside smooth and pearly. The outside has concentric markings (owing to laminations) decorated with radial sculpturings. General appearance of outside more laminated than smooth. Inside, there are two shallow laminated bays near the hinge corners. The valves very much resemble mica sheets in consistency, and in olden times were frequently used as window panes.

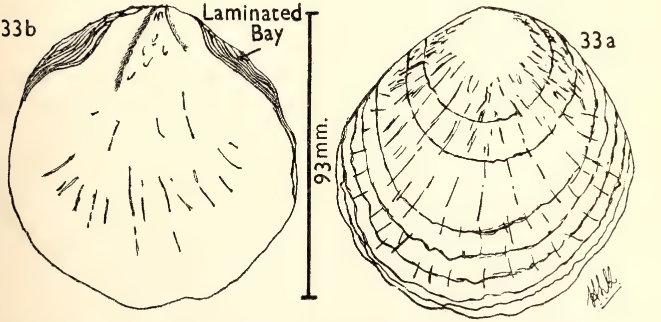
Pirotan Island.

Family OSTREIDAE (True Oysters)

The valves are dissimilar and somewhat irregular. The left valve is anchored to the substratum and the hinge is toothless.


31a
31b
27 mm.


32a
32b
36 mm.


33b
Laminated Bay
93mm.
33a

Figs. 31a, 31b. *Lima lima*: outer and inner views respectively;
Figs. 32a, 32b. *Anomia achaeus*: outer and inner views respectively;
Figs. 33a, 33b. *Placenta placenta*: outer and inner views respectively

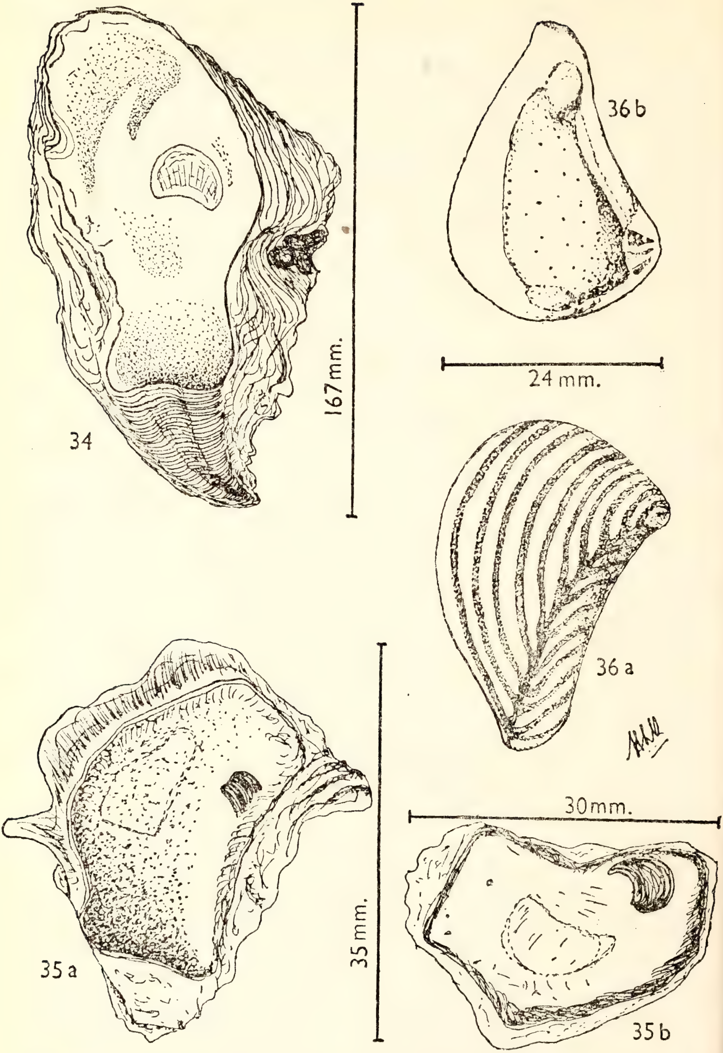

36 b
24 mm.
167 mm.
34
36 a
30 mm.
35 a
35 mm.
35 b

Fig. 34. *Ostrea madrasensis*: the left valve; Figs. 35a, 35b. *Ostrea folium*: the left and the right valve respectively; Figs. 36a, 36b. *Crassatella rostrata*: outer and inner views respectively

Genus **Ostrea** Linné

The characters are as described for the family.

33. **Ostrea madrasensis** Preston. Plate X, fig. 34

No radial folds upon the valves. The right valve is like a deep spatula. Its margin is even and its shape elongate. Ligamentary area triangular with a median triangular depression and two lateral triangular ridges. The whole area is covered with transverse striations which conform with growth. Adductor impression in centre of valve. Left valve very thick and the sides laminated. Left valve only.

Pirotan Island (obtained from the keepers of the lighthouse).

34. **Ostrea folium** Gmelin. Plate X, figs. 35a, 35b

A complete specimen was found. Left valve somewhat arched and right valve thin, rectangular, and plate-like, with ridge-like fold in middle. Colour of both valves is deep purple, powdery white inside. Sides of valves plain. Two horn-like processes on left valve.

Pirotan Island.

NOTE. According to Hornell, 1951, p. 91, owing to their constant variability, the identification of Ostreids is difficult.

Family CRASSATELLIDAE

The shell is small, thick, ovate, and the posterior margin has the shape of an elongated 'S'. The surface bears thick concentric ridges.

Genus **Crassatella** Lamarck

Valve an inequivalve with hind margin either truncated or beaked. Cardinal teeth distinct while lateral teeth are hardly developed.

35. **Crassatella rostrata** Lamarck. Plate X, figs. 36a, 36b

Shell glossy and light brown. Two cardinal teeth in the left valve and three in right, of which the large middle one fits between the two teeth of left valve. A definite beak in postero-ventral edge. Thick and regular concentric striations upon the surface. The number of the striations increases with age. In the series in our collection the striations range from 11 (length = 13·5 mm.) to 15 (length = 24·4 mm.). The inside is smooth and bears a small pallial sinus. The outside of some is white while others have radial streaks of brown.

Hanuman Dandi.

Family CARDITIDAE (False Cockles)

Small heavy shells with strong radial ribs. The cardinal teeth are often so shaped as to lead to the formation of one in the left and two long posterior teeth in the right valve. The anterior cardinal and lateral teeth are mostly rudimentary. The ligament is external and the pallial sinus is lacking.

Genus **Cardita** Bruguière

The shell is roundishly ovate and has a strong umbo.

36. **Cardita bicolor** Lamarck. Plate XI, figs. 37a, 37b

Shell strong, inflated with thick wide ribs; anterior ribs bear transverse striations which thin out posteriorly; 2 to 3 distinct circular grooves (growth lines) traverse both ribs and interstices; interstices deep and narrow; inside powdery white with somewhat sunk adductor impressions and no pallial sinus. V-shaped depressions upon rim of inside corresponding to the ribs and interstices.

Pirotan Island. Hanuman Dandi.

Genus **Beguina** (Bolten) Röding

Shell elongated; umbo placed anteriorly.

37. **Beguina variegata** (Bruguiére). Plate XI, figs. 38a, 38b

Shell dull-white in colour and elongated, with strong ribs which radiate almost from the anterior tip. Anterior ribs narrow, but ribs passing over keel very thick. Definite circular markings which appear like scales upon the ribs. A slight indentation under umbo and a wide depression upon ventral margin.

Pirotan Island.

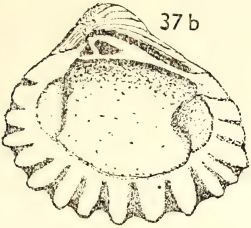
Family LIBITINIDAE

Elongate shell with umbo much in the front, two cardinal teeth and a long posterior lateral and a short anterior tooth. Members of this family have not been reported from the Karwar coast (Patil 1952) but have been included by Gravely (1941) in his list of the shells of Madras beach.

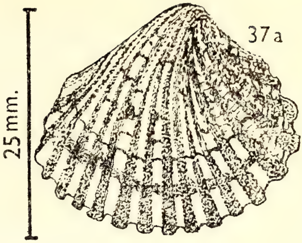
Genus **Libitina** Schumacher

Characters as described for the family.

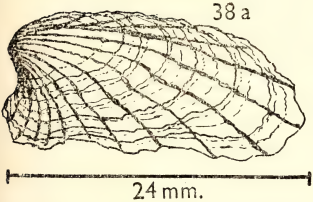
37 b



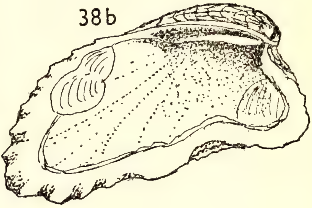
37 a



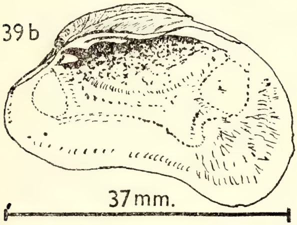
38 a



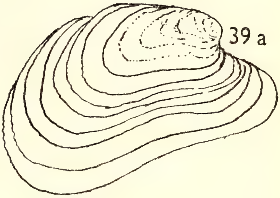
38 b



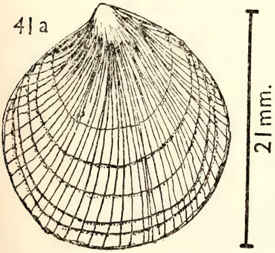
39 b



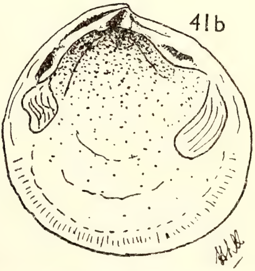
39 a



41 a

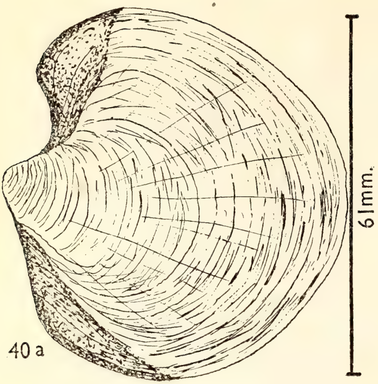


41 b

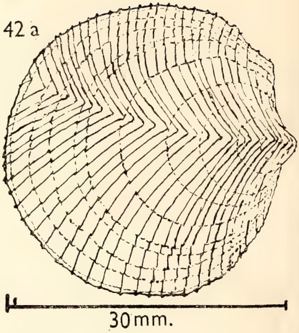


Figs. 37a, 37b. *Cardita bicolor* : outer and inner views respectively;
Figs. 38a, 38b. *Beguina variegata* : outer and inner views respectively;
Figs. 39a, 39b. *Libitina vellicata* : outer and inner views respectively;
Figs. 41a, 41b. *Codakia divergens* : outer and inner views respectively

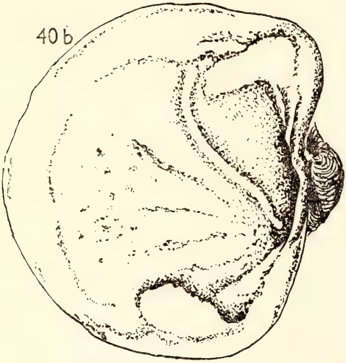
40 a



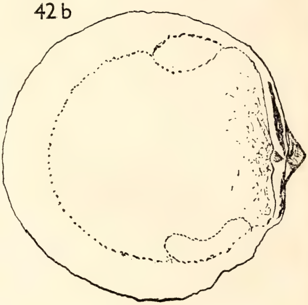
42 a



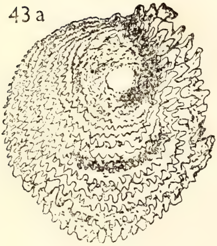
40 b



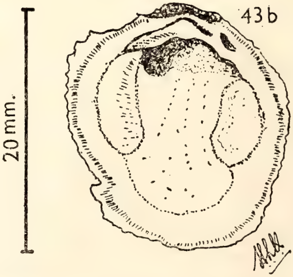
42 b



43 a



43 b



Figs. 40a, 40b. *Lucinia edentula*: outer and inner views respectively;
Figs. 42a, 42b. *Divaricella cumingii*: outer and inner views respectively;
Figs. 43a, 43b. *Chama spinosa*: outer and inner views respectively

38. **Libitina vellicata** (Reeve). Plate XI, figs. 39a, 39b

A dull-white shell with moderately fine concentric lines over the entire surface; a shallow keel runs from the umbo to the postero-ventral end of rim; ventral side somewhat incurved with a depression just in front of umbo; posterior adductor impression bigger than anterior; pallial sinus present. The inside is brownish white.

Pirotan Island.

Family LUCINIDAE (Bladder Shells)

Shells mostly inflated, with rather narrow anterior adductor scar, and none or feeble hinge teeth. The umbones are close and the lunule is asymmetrical. Lucinids are fairly common in Gulf of Kutch, as the empty shells are washed ashore in large numbers. However, they have not been reported from the Karwar coast (Patil 1952).

Genus **Lucinia** Lamarck

Shell large, moderately thin, toothless, with fine concentric striations.

39. **Lucinia edentula** (Linné). Plate XII, figs. 40a, 40b

A large, white shell with fine concentric striations upon the surface. Inside, a shallow keel which runs from approximately the middle of hinge joint to posterior end through the middle of scar of posterior adductor muscle. From anterior end of this keel runs an oblique depressed line up to ventral end of scar of anterior adductor. Lunule a bit depressed and sculpturing at anterior end is somewhat coarse.

Pirotan Island.

Genus **Codakia** Scopoli

Valves moderately inflated and characterized by many radial and a few concentric striations. Cardinal and lateral teeth present. The shell looks like a bi-convex lens.

40. **Codakia divergens** (Philippi). Plate XI, figs. 41a, 41b

Shell white, somewhat heavy, and a little inequilateral. Slight depression in front of umbo; radial ribs many, distinct, and divaricate both anteriorly and posteriorly; extremely fine concentric rings occur all over outer surface; growth lines few (4 in this case) and deep. Area in front of umbo slightly depressed. Two small cardinal teeth present. Inside smooth and pale yellow.

Hanuman Dandi. Pirotan Island.

Genus **Divaricella** Martens

Shell round, inflated, and uniformly divaricated.

41. **Divaricella cumingii** (A. Adams & Angas). Plate XII, figs. 42a, 42b

A glossy, hard, light, and equivalve shell; hinge almost straight with two shallow cardinal teeth; there are angulations in the anterior rim. Inner surface chalky and rim crenate. Outside chracterized by a series of V-shaped divaricating ribs, apices of which are directed towards umbo; the apices arranged in a line from the umbo to antero-ventral edge of rim. Concentric growth lines fairly prominent and deep.

Hanuman Dandi. Pirotan Island.

Family CHAMIDAE

Shell heavy and left valve attached to substratum. Hinge margin thick, with large teeth. Surface beset with circular rows of spines of various shapes and sizes.

Genus **Chama** (Linné)

This is the only genus of the family.

42. **Chama spinosa** Broderip. Plate XII, figs. 43a, 43b

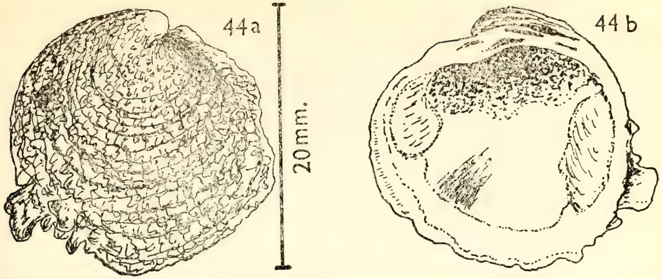
Shell nearly flat and orbicular; upper valves covered profusely with minute scaly spines, which are long and laminiferous towards the umbones. Shell dark-brown; rim of the inside finely crenulate.

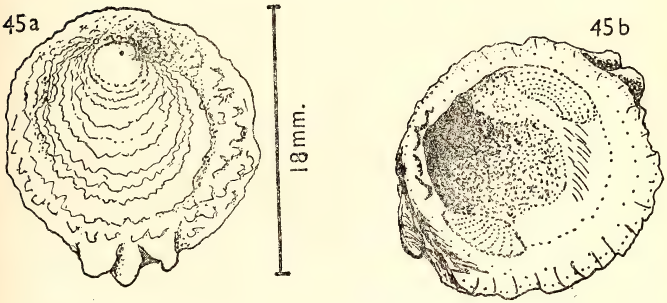
Veraval.

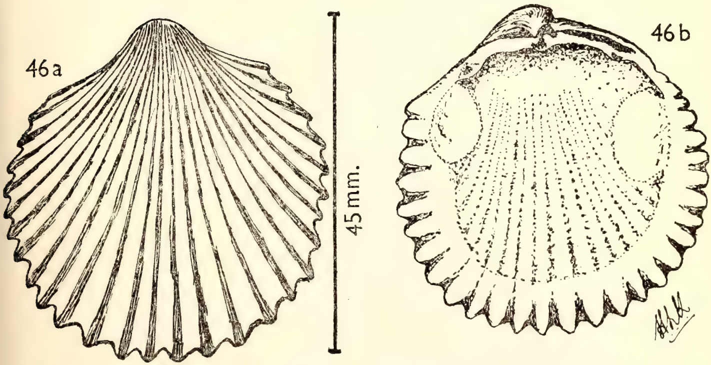
43. **Chama fragrum** Reeve. The Strawberry Chama. Plate XIII, figs. 44a, 44b

Shell rounded and light-pink, with fine scaly spines arranged in concentric rings; impressions of radial ribs present; spines upon two posterior radial ribs larger than the rest. Upon these ribs, the peripheral scales are very large and foliaceous. Between these two radial rows, circular rows of very fine and uniform scaly spines. Valve fairly deep and umbo directed forwards. Only the right valve.

Veraval.

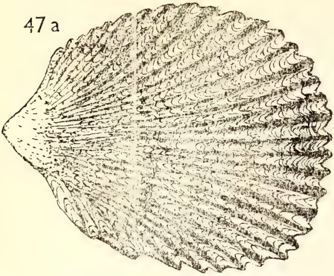

44a
20mm.
44 b


45a
18mm.
45b

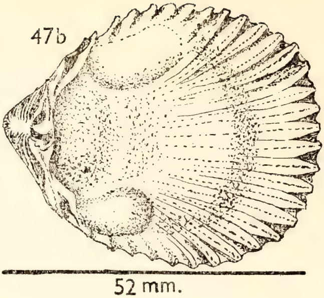

46a
45mm.
46b

Figs. 44a, 44b. *Chama fragrum*: outer and inner views respectively;
Figs. 45a, 45b. *Chama reflexa*: outer and inner views respectively;
Figs. 46a, 46b. *Cardium asiaticum*: outer and inner views respectively

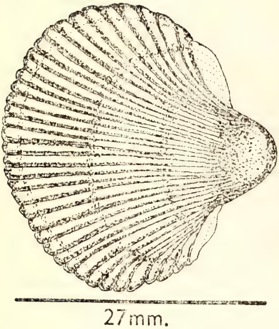
47 a



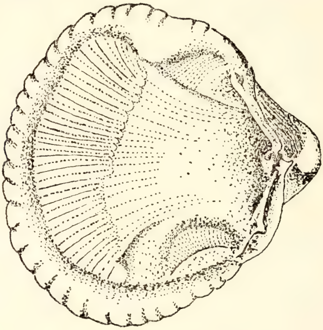
47 b



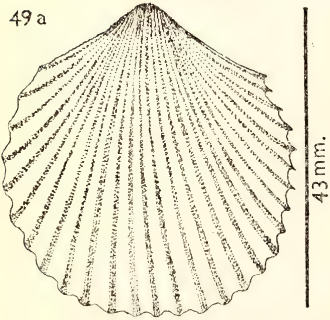
48 a



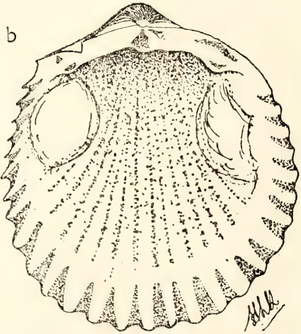
48 b



49 a



49 b



Figs. 47a, 47b. *Cardium assimile*: outer and inner views respectively;
Figs. 48a, 48b. *Cardium australe*: outer and inner views respectively;
Figs. 49a, 49b. *Cardium flavum*: outer and inner views respectively

44. **Chama reflexa** Reeve. Plate XIII, figs. 45a, 45b

A very heavy, inflated, flesh-coloured shell, with short tubular spines arranged in circular rows. A few (3 here) of the ventral scales triangular and large. Inside crenulated. According to Gravely (1941) the shape of this shell is extremely variable.

Veraval.

Family CARDIIDAE (Cockles)

This important family has nearly rounded shells with strong radial ribs, external ligament, and similar hinge teeth on both the valves. There are two cardinal teeth and two lateral teeth.

Genus **Cardium** Linné

Shell mostly evenly curved; ribs often scaly or tuberculated.

45. **Cardium asiaticum** Bruguiére. Plate XIII, figs. 46a, 46b

Shell thin and rounded; ribs almost smooth, crested, with strong internal impressions; side walls of ribs finely granular; concentric lines nearly imperceptible, except at the interstices of a few posterior ribs where these lines are only barely perceptible.

Hanuman Dandi.

46. **Cardium assimile** Reeve. Plate XIV, figs. 47a, 47b

A large pinkish shell in which height is much more than length; ribs strongly developed, with fine serrations which, in a few of the hindmost ribs, have assumed the form of tubercles. Inside smooth and glossy, with posterior side somewhat truncated and anterior side roundish. Very common and attains considerable size.

Pirotan Island.

47. **Cardium australe** Sowerby. Plate XIV, figs. 48a, 48b

Shell smooth, with ribs having tendency to fade out near the umbo, leaving it absolutely smooth. The shell is pale brown, roundish (with faint angulation in posterior side), and moderately heavy. In fresh specimens tip of umbo has pinkish hue. Internally, there is a thin keel which starts from the umbo and reaches the posterior boundary of the posterior adductor scar.

Pirotan Island. Hanuman Dandi.

48. **Cardium flavum** Linné. Plate XIV, figs. 49a, 49b

Shell thick with rather squarish outline. Upon the outer surface about 29 to 30 strong radial ribs with deep interstices and fine concentric markings. Upon hind ribs, the circular rings form laminar tubercles. Outside dull white but inner surface glossy and white. The valves are a little oblique.

Pirotan Island.

49. **Cardium setosum** Redfern. Plate XV, figs. 50a, 50b

Readily distinguished from the previous species by: length exceeding height, flattened ribs, narrow interstices, and rows of seta-like tubercles upon ribs. Tubercles, when present, are arranged in single file upon the ribs. On posterior and anterior ribs, they occur on all the ribs and extend to the umbo; in other areas they are discontinuous. In the ventro-posterior area, the tubercles are generally on alternate ribs. Externally, shell yellowish with concentric brownish patches; internally, it presents smooth glossy white surface with a tinge of yellow which fans out from the umbo. These shells grow to large size (we have shells 45 mm. in length).

Veraval.

Family VENERIDE (Clams)

A very large family, with many representatives in the Gulf of Kutch. Characterized by a regular shell, three cardinal teeth ('with an additional tooth in front of the left valve and a hollow on the right'), and a sinuate pallial line.

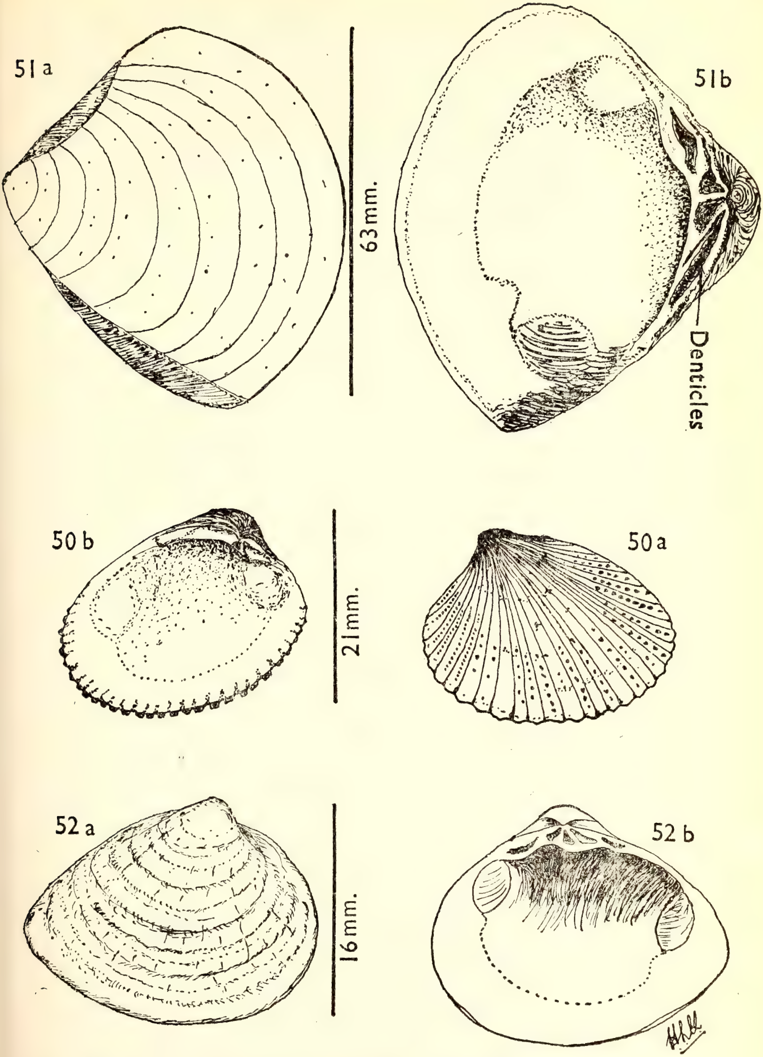
Genus **Meretrix** Lamarck

Shell heavy, smooth, nearly triangular, with a thin glossy periostracum which tends to peel off in museum specimens. Hinge thick, with three cardinal teeth; pallial sinus small. Easily recognized by presence of fine transverse striations upon posterior lateral tooth of left valve and corresponding depression on right valve.

From an extensive study of *Meretrix* of Indian waters, Hornell (1917) concluded that in India there are three distinct species of *Meretrix* with many varieties in each: *Meretrix meretrix* (Linn.), *Meretrix attenuata* Dunker, and *Meretrix casta* (Chemnitz). Of these the first and the last have been collected by us from the Gulf of Kutch.

50. **Meretrix meretrix** (Linné). Plate XV, figs. 51a, 51b

Valve trigono-sub-orbicular with a few smooth concentric growth lines. The surface is covered by a thin pale brown periostracum. There is a characteristic dark chevron-shaped radial patch extending


51 a
51 b
63 mm.
Denticles
50 b
21 mm.
50 a
52 a
16 mm.
52 b

Figs. 50a, 50b. *Cardium setosum*: outer and inner views respectively;
Figs. 51a, 51b. *Meretrix meretrix*. outer and inner views respectively;
Figs. 52a, 52b. *Meretrix casta*: outer and inner views respectively

from the umbo to the ventral hind corner where it shows up even internally. There is also a characteristic notch in the anterior cardinal tooth of the left valve.

Pirotan Island.

51. **Meretrix casta** (Chemnitz). Plate XV, figs. 52a, 52b

Shell somewhat ovate and pinkish in general colour with alternate concentric rings of darker and lighter shades. Also there are fine rays of pinker hue. According to Hornell (1917), 'this species is exceedingly variable and ignorance of this fact has caused great confusion over its nomenclature'.

Veraval.

(to be continued)

More Cyanophyceae of Hoshiarpur : III

BY

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(*With two plates*)

[*Continued from Vol.* **60** (3) : 678]

An extensive collection and a continuous study of the Cyanophycean flora of Hoshiarpur form the subject matter of the present communication which is the fourth in the series. It incorporates records and descriptions of sixty species belonging to 21 genera. One new species, seven new varieties, and five new forms have been included in this work. In the previous communications [*J. Bombay nat. Hist. Soc. Vols.* **57**(3), **58**(1), and **60**(3)] the author described 114 species belonging to 32 genera, and this paper brings the total to 174 species belonging to 34 genera.

Anabaena volzii Lemm. forma *recta* Kiss., *Scytonema saleyeriense* Weber van Bosse, and *S. chiastum* Geitler have been, to the best of the author's knowledge, described for the first time from the Indian soil.

Cyanophyceae described in the present paper have been mainly collected from both aquatic and terrestrial habitats. *Phormidium bigranulatum* Gardner forma *major* f. nov. is a common endophytic blue-green alga growing within the gelatinous envelope of *Aphanothece pallida* and some species of *Rivularia*. *Rivularia aquatica* De Wilde and *Gloeotrichia natans* Rabenh. are the common epiphytic blue-green algae that usually grow on the leaves and stems of submerged angiosperms and some green algae like *Chara* and *Nitella*. *Aphanothece pallida* (Kütz.) Rabenh. commonly forms a blue-green or yellowish green gelatinous growth on moist brickwork or soil during the rainy season. The thallus becomes papery and yellowish brown after the rains. During the drier periods the cells show extensive spore formation.

Systematic enumeration of the Species observed

Order **CHROOCOCCALES** Wetstein

Family **CHROOCOCCACEAE** Nägeli

CHROOCOCCUS Nägeli

1. **Chroococcus turgidus** Näg. in Gatt. Einzell. Algen 46, 1849; Desikachary, Cyanophyta 101, pl. 26, fig. 6, 1959.

Diameter cell with sheath = 19·2-23·04 μ ; diameter cell without sheath = 11·5-15·3 μ ; sheath colourless, not distinctly lamellated ; contents blue-green.

Habitat : Planktonic in a roadside pond, Hoshiarpur. Mixed with other algae. June 24, 1960.

2. **Chroococcus varius**, A. Br. in Rabenhorst's Alg. Eur. 246, 248, 2452, 2459, 1863-78 ; Desikachary 107, pl. 24, fig. 5, 1959.

Diameter cell without sheath = 2·7-3·8 μ ; diameter cell with sheath = 5·1-8·5 μ ; sheath indistinctly lamellated ; cells single or in fours, rarely in bigger groups ; sheath colourless or yellow.

Habitat : On the cemented side of a water tank, Government College, Hoshiarpur. May 5, 1960.

GLOEOCAPSA Kützing

3. **Gloeocapsa nigrescens** Näg. in Rabenhorst's Alg. Sachs. 63, 629, 1875 ; Desikachary 117, pl. 24, figs. 15, 17, 1959.

Diameter cell without sheath = 3·8-6·6 μ ; diameter cell with sheath = 11·5-13·4 μ ; sheath colourless, unlamellated, broad ; spores not observed.

Habitat : On moist soil, Hoshiarpur. Mixed with *G. polydermatica* and *Phormidium foveolarum.* June 16, 1960.

GLOEOTHECE Nägeli

4. **Gloeothece membranacea** Bornet in Alg. de Schousb., Mem. Soc. Nat. Sci. 28 : 175, 1892 ; Desikachary 128, 1959.

Long. cell without sheath = 7·6-9·5 μ ; long. cell with sheath = up to 11·5 μ ; lat. cell without sheath = 4·7-6 μ ; lat. cell with sheath = 7·6-9·5 μ.

Habitat : In a glass trough containing algae in Botanical Laboratory, Government College, Hoshiarpur. October 27, 1960.

APHANOTHECE Nägeli

5. **Aphanothece pallida** Rabenh. Fl. Eur. Alg. 2 : 64, 1865 ; Kryptog. Fl. Sachosen 1 : 76, 1863 ; Desikachary 140, pl. 22, fig. 3, 1959. *Microcystis pallida* Lemm. Kryptogamenfl. Mark Brandenb. 3 : 77, 1907.

Lat. cell without sheath = 6·6-8 μ ; lat. cell with sheath = 7·6-9·5 μ ; long. cell without sheath = 9·5-12·1 μ ; long. cell with sheath = 11·5-19·2 μ ; cells oblong, elliptical or cylindrical.

Habitat : On moist soil of lawns, Government College, Hoshiarpur. August 8, 1960.

MERISMOPEDIA Meyen

6. **Merismopedia punctata** Meyen in Wiegmann, Archiv. 2: 67, 1839; Desikachary 155, pl. 23, fig. 5 & pl. 29, fig. 6, 1959.

Colonies small, 32-celled, 21·1 μ broad; cells spherical or ovoid, 2·5-3·4 μ broad.

Habitat : Planktonic in a stagnant water roadside pond, Phagwara Road, Hoshiarpur. October 15, 1959.

SYNECHOCYSTIS Sauvageau

7. **Synechocystis pevalekii** Ercegovic in Acta Bot. inst. Bot. Univ. R. Zagreb 1 : 77, pl. 1, fig. 8, 1925; Desikachary 145, pl. 25, fig. 11, 1959. (Plate I, Fig. 1).

Cells spherical, contents blue-green, homogenous, single or two together, 2·7-3·4 μ diam.

Habitat: Planktonic in a stagnant water pond, Phagwara Road, Hoshiarpur. June 8, 1960.

Order NOSTOCALES Geitler

Family OSCILLATORIACEAE Kirchner

SPIRULINA Turpin ex Gardner

8. **Spirulina major** Kütz. ex Gomont. [Kützing, Phyc. Gene. 183, 1843]; Gomont, Mon. Oscill. 251, pl. 7, fig. 29, 1892; Desikachary 196, pl. 36, fig. 13, 1959.

Lat. trichome = 1·7-2 μ; Spirals = 3-5·1 μ distant, 2·5-3·8 μ broad; regularly spirally coiled.

Habitat: In stagnant water, mixed with *Oscillatoria jasorvensis.* May 14, 1960.

OSCILLATORIA Vaucher

9. **Oscillatoria perornata** Skuja in Nov. Acta Reg. Soc. Uppsal. (ser. 4) 14 : 47, pl. 8, figs. 7-9, 1949; Desikachary 205, pl. 41, figs. 8, 9, 14, 1959.

Trichomes single or aggregated, briefly attenuated at the ends, constricted at the cross walls, 13·4-15·3 μ broad; cells small, 2·7-5·7 μ long, contents granular, septa granulated; end cell hemispherical; calyptra absent.

Habitat: On the inner side of a tube well, Government College, Hoshiarpur. October 1, 1960.

10. **Oscillatoria curviceps** Ag. ex-Gomont. [Agardh, Syst. Alg. 68, 1824]; Gomont, Mon. Oscill. 213, pl. 6, fig. 14, 1892; Desikachary 209, pl. 38, fig. 2, 1959. form described by Parukutty *in* Proc. Indian Acad. Sci. 11: 120, 1940.

Lat. trichome = 7·6-11·1 μ; long. cell = 1·9-2·7 μ.

Habitat: On the sides of a tube well, Hoshiarpur. Mixed with *Osc. perornata* and *Osc. formosa.* October 1, 1960.

11. **Oscillatoria jasorvensis** Vouk in Jugosl. Akad. Zagreb, 14: 133, fig. 1, 1919; Desikachary 221, 1959.

Lat. trichome = 2·5-3·8 μ; long. cell = 2·5-3·8 μ; end cell rounded, calyptra absent.

Habitat: From the sides of a water course at Chak Saidu, Hoshiarpur. May 12, 1960.

12. **Oscillatoria limnetica** Lemm. in Ber. deutsch. bot. Ges. 18: 310, 1900; Desikachary 226, pl. 37, fig. 3, 1959.

Lat. cell = 1·5-1·7 μ; long. cell = 8·5-11·9 μ; calyptra absent.

Habitat: Mixed with *Osc. jasorvensis* Vouk. May 12, 1960.

13. **Oscillatoria amoena** Gomont var. **major** var. nov. (Plate I, Fig. 2).

Thallus caeruleo-viridis; trichomata constricta, attenuata ad apicem, 3·8-6·6 μ lata; contentis caeruleo-viridibus, septis transversis granularibus; cellulae 3·8-4·7 μ longae; cellula terminalis capitata, conica; calyptra adest. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 21.

Thallus blue-green; trichomes constricted, attenuated at the ends, 3·8-6·6 μ broad; contents blue-green, septa granulated; cells 3·8-4·7 μ long; end cell capitate, conical; calyptra present.

Habitat: In a roadside pond at Hoshiarpur. Collected on February 6, 1960 and deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 21.

The variety differs from the type in possessing broader trichomes.

14. **Oscillatoria annae** Van Coor forma **minor** f. nov. (Plate I, Fig. 3).

Trichomata recta vel curva, attenuata ad apicem, 6·6-7·6 μ lata; cellulae 2·5-3·8 μ longae; cellula terminalis rotundata; calyptra nulla. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 22.

Trichomes straight or curved, attenuated at the ends, 6·6-7·6 μ broad; cells 2·5-3·8 μ long; end cell rounded; calyptra absent.

Habitat : In a roadside pond at Hoshiarpur. May 24, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 22.

The form differs from the type in possessing smaller dimensions of the trichome.

15. **Oscillatoria proboscidea** Gomont forma **hoshiarpurensis** f. nov. (Plate I, Fig. 4).

Trichomata recta vel curva, caeruleo-viridia, attenuata ad apicem, 7·6-8·5 μ lata; cellulae 1·9-2·5 μ longae; cellula terminalis capitata, rotundata; calyptra adest. Posita in Government College, Hoshiarpur herbario sub numero *Vasishta* 23.

Trichomes straight or curved, blue-green, attenuated at the ends, 7·6-8·5 μ broad; cells 1·9-2·5 μ long; end cell capitate, rotund; calyptra present.

Habitat : On the sides of a cemented reservoir, Government College, Hoshiarpur. May 26, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 23.

The form differs from the type in possessing smaller dimensions of the trichomes.

16. **Oscillatoria foreaui** Fremy forma **minor** f. nov. (Plate I, Fig. 5).

Thallus caeruleo-viridis; trichomata curva, raro recta, constricta ad septa, 1·9-2·5 μ lata; cellulae 1·7-1·9 μ longae; cellula terminalia late conica; calyptra nulla. Posita in Government College, Hoshiarpur herbario sub numero *Vasishta* 24.

Thallus blue-green; trichomes curved rarely straight, constricted at septa, 1·9-2·5 μ broad; cells 1·7-1·9 μ long; end cell broadly conical; calyptra absent.

Habitat : On moist soil, Hoshiarpur. July 14, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 24.

The form differs from the type in possessing narrower trichomes.

PHORMIDIUM Kützing

17. **Phormidium tenue** Gomont, Mon. Oscill. 169, pl. 4, figs. 23-25, 1892; Desikachary 259, pl. 43, figs. 7-9, 1959.

Lat. trichome = 1·7-2 μ; long. cell = 2·7-5·1 μ; trichomes slightly constricted at the septa; end cell conical.

Habitat : Forming a blue-green thallus on the sides of a tank in ice factory at Hoshiarpur. June 29, 1960.

18. **Phormidium papyraceum** Gomont 173, pl. 5, figs. 3-4, 1892; Desikachary 271, 1959.

Lat. trichome = 3·8-5·1 μ; long. cell = 3·8-4·7 μ.

Habitat : In a temporary ditch by the side of railway track, Hoshiarpur. May 30, 1960.

[25]

19. **Phormidium africanum** Lemm. Deutsche Zentr. Afr. Exped. 2 : 89, 1911 ; Desikachary 254, 1959.

Trichomes constricted at the septa, 1·7-2 μ broad ; cells 1·7-3·4 μ long ; end cell truncated with a calyptra.

Habitat : On the bottom of a pond, Phagwara Road, Hoshiarpur. November 5, 1960.

20. **Phormidium angustissimum** W. et G. S. West in Jour. Bot. Lond. 35 : 298, 1897 ; Desikachary 253, 1959.

Thallus thin, blue-green ; trichomes bent and entangled, constricted at cross walls, 0·85-1·2 μ broad ; cells cylindrical, 3·8-7·6 μ long ; end cell not capitate.

Habitat : On moist soil, Hoshiarpur. June 6, 1960.

21. **Phormidium jenkelianum** Schmid forma **majus** f. nov. (Plate I, Fig. 6).

Trichomata pallide caeruleo-viridia, curva, constricta, 2·5-3 μ lata ; cellulae 1·7-2 μ longae ; cellula terminalis rotundata ; calyptra nulla. Posita in Government College, Hoshiarpur herbario sub numero *Vasishta* 25.

Trichomes light blue-green, curved, constricted, 2·5-3 μ broad ; cells 1·7-2 μ long ; end cell rounded ; calyptra absent.

Habitat : Along the sides of botanical tank, Government College Hoshiarpur. May 23, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 25.

The form differs from the type in possessing broader trichomes.

22. **Phormidium favosum** Gomont var. **minus** var. nov. (Plate I, Fig. 7).

Thallus caeruleo-viridis, complanatus ; filamenta 5.7-6.6 μ lata ; vagina tenuis ; trichomata 3·8-4·7 μ lata, attenuata ad apicem ; cellulae aeque longae ac latae, 3·8-4·7 μ longae, septa transversalia granulata ; cellula terminalis rotundata; calyptra adest. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 26.

Thallus blue-green, expanded ; filaments 5·7-6·6 μ broad ; sheath thin ; trichomes 3·8-4·7 μ broad, attenuated at the ends ; cells as long as broad, 3·8-4·7 μ long, septa granulated ; end cell rounded ; calyptra present.

Habitat : Amidst the plants of *Marchantia nepalensis* at Bharwain, Hoshiarpur, July 8, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 26.

The variety resembles the type in possessing : (a) granulated septa, (b) trichomes attenuated and not constricted at the septa, and (c) end cell rounded, capitate and calyptrate ; but differs in possessing smaller dimensions of the filaments and the trichomes.

23. **Phormidium usteri** Schmidle in Hedwigia 6: 414, 1904; Desikachary 257, 1959.

Lat. filament = 3·8-4·7 μ; long. cell = 2·7-3 μ; lat. trichome = 3·4-4 μ; end cell broadly rounded; calyptra absent.

Habitat: Floating in a roadside pond near village Sham Chaurassi, Hoshiarpur. May 29, 1960.

24. **Phormidium abronema** Skuja in Susswasseralg. Burmas 50, pl. 8, fig. 25, 1949; Desikachary 257, 1959 (Plate I, Fig. 8).

Lat. filament = 4·7-7·6 μ; lat. trichome = 3·4-4·5 μ; long. cell = 3·8-7·6 μ; trichomes attenuated at the ends, constricted at the septa; end cell conical; calyptra absent.

Habitat: On moist soil, Hoshiarpur. June 1, 1960.

25. **Phormidium pachydermaticum** Fremy, Myxo. Afr. Equat. Franç. 156, fig. 138, 1929; Desikachary 267, pl. 43, figs. 8-10, 1959.

Thallus dull blue-green; filaments straight or slightly curved, 6·6-8·5 μ broad; sheath distinct, thick, lamellated; trichomes unconstricted, 5·7-6·6 μ broad, trichome ends straight, not attenuated; end cell conical with obtuse apex: cells 3.4-5.7 μ long; calyptra may be present.

Habitat: On tree trunks, Hoshiarpur. July 21, 1960. The type is being reported for the first time from the Indian soil.

26. **Phormidium jadinianum** Gomont in Bull. Soc. Bot. Fr. 40: 161, 1893; Desikachary 256, pl. 55, fig. 9, 1959.

Filaments long and more or less parallel, 7·6 μ broad; trichomes 4-6 μ broad, constricted; cells 3·8-4·6 μ long; end cell acute conical; calyptra absent.

Habitat: On the bark of *Mangifera indica*, Hoshiarpur. July 18, 1960.

27. **Phormidium inundatum** Kütz. ex-Gomont. [Kützing, Species Algarum 251, 1849]; Gomont, Mon. Osc. 172, pl. 4, figs. 31-32, 1892; Desikachary 271, 1959.

Lat. filament = 5-6·6 μ; lat. trichome = 3·8-5·7 μ; long. cell = 3·8-7·6 μ; not constricted at the cross walls; septa granulated; end cell obtuse conical; calyptra absent.

Habitat: On moist walls, Hoshiarpur. August 17, 1960.

28. **Phormidium bigranulatum** Gardner forma **major** f. nov. (Plate I, Fig. 9).

Filamenta longa, recta vel curva, 1·7-1·9 μ lata; trichomata 1·5-1·7 μ lata; cellulae longae, cylindricae, septa transversalia granulata, 3·4-5·1 μ longa. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 27.

Filaments long, straight or curved, 1·7-1·9 μ broad; trichomes 1·5-1·7 μ broad; cells long, cylindrical, septa granulated, 3·4-5·1 μ long.

Habitat : In the gelatinous thalli of *Aphanothece pallida*, August 11, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 27.

The form differs from the type in possessing broader filaments and trichomes. The length of the cells is also a little lesser than that reported for the type.

29. **Phormidium subfuscum** Gomont var. **joannianum** Gomont, Mon. Oscill. 184, 1892; Desikachary 273, 1959.

Lat. trichome = 5·7-7 μ; long. cell = 3·8-4 μ; end cell conical with acute apex; septa granulated.

Habitat : On moist soil, Hoshiarpur. August 26, 1960.

30. **Phormidium dimorphum** Lemm. Arch. Hydrobiol. (u. Plankton.) 4: 187, pl. 5, figs. 25-28, 1908; Desikachary 256, pl. 54, fig. 8, 1959.

Lat. filament = 5·1-6 μ; lat. trichome = 3·5-5·1 μ; long. cell = 3-5·7 μ; trichomes constricted; end cell hemispherical; calyptra absent.

Habitat : Along the sides of a puckka drain, Hoshiarpur. August 30, 1960.

31. **Phormidium uncinatum** Gomont, Mon. Oscill. 184, pl. 5, figs. 21-22, 1892; Desikachary 276, pl. 43, figs. 1-2, pl. 45, figs. 9-10, 1959.

Lat. filament = 8·5-11·5 μ; lat. trichome = 6·6-9·5 μ; long. cell = 2·7-5·7 μ; cross walls granulated; end cell with a calyptra.

Habitat : On moist soil, Hoshiarpur. September 2, 1960.

32. **Phormidium stagninum** Rao in Jour. Indian Bot. Soc. 17: 93, figs. 4-7, 1938; Desikachary 265, pl. 45, figs. 16-18, 1959.

Lat. filament = 12·1-13·4 μ; lat. trichome = 10·5-11·5 μ; long. cell = 1·9-2·7 μ; calyptra present.

Habitat : Along the side of a drain, Hoshiarpur. September 24, 1960.

33. **Phormidium stagninum** Rao var. **robustum** var. nov. (Plate I, Fig. 10).

Thallus caeruleo-viridis; filamenta longa et curva, 15·3-19·2 μ lata; vagina distincta, hyalina; trichomata non-constricta, 11·5-15·3 μ lata; cellulae 1·9-2·7 μ longae, contentis granularibus; cellula terminalis rotundata; calyptra adest. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 28.

Thallus blue-green ; filaments long and curved, 15·3-19·2 μ broad ; sheath distinct, hyaline ; trichomes unconstricted, 11·5-15·3 μ broad ; cells 1·9-2·7 μ long, contents granular ; end cell rounded ; calyptra present.

Habitat : On moist soil, Hoshiarpur. August 27, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 28.

The variety resembles the type in possessing unattenuated, unconstricted trichomes with a distinct calyptra ; but differs in the broader dimensions of filaments and trichomes.

34. **Phormidium hoshiarpurense** sp. nov. (Plate I, Figs. 11-13).

Thallus caeruleo-viridis ; filamenta longa, recta vel curva, 5·7-6·8 μ lata ; vagina tenuis, hyalina, distincta ; trichomata non-constricta, caeruleo-viridia, 5·1-5·7 μ lata ; cellulae 1·7-1·9 μ longae, granulatae ad septa ; cellula terminalis rotundata ; calyptra adest. Typus lectus die 24 septembris anni 1960 et positus in Hoshiarpur herbario Collegii Gubernii sub numero *Vasishta* 4341.

Thallus blue-green ; filaments long, straight or curved, 5·7-6·8 μ broad ; sheath thin, hyaline, distinct ; trichomes not constricted, blue green, 5·1-5·7 μ broad ; cells 1·7-1·9 μ long, granulated at septa ; end cell rounded ; calyptra present.

Habitat : In a stagnant water ditch, Phagwara Road, Hoshiarpur. Collected on September 24, 1960 and deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 4341.

This species resembles *Phormidium stagninum* Rao (1938) in the following respects : (*a*) trichomes unconstricted and unattenuated, and (*b*) end cell rounded and calyptrate ; but differs in possessing (*a*) smaller dimensions of the trichomes and filaments, and (*b*) granulated septa. This species, therefore, may be regarded as new and is named as *Phormidium hoshiarpurense* sp. nov.

35. **Phormidium valderianum** Gomont var. **minus** var. nov. (Plate II, Fig. 14).

Thallus pallide viridis ; trichomata curva, non-constricta, non-attenuata, 1·7-1·9 μ lata ; cellulae cylindricae, 5·7-6·8 μ longae ; septa granulata ; cellula terminalis rotundata ; calyptra nulla. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 29.

Thallus pale green ; trichomes curved, not constricted, not attenuated, 1·7-1·9 μ broad ; cells cylindrical, 5·7-6·8 μ long ; septa granulated ; end cell rounded ; calyptra absent.

Habitat : On stones in rapidly flowing water at Bharwain, Hoshiarpur. July 6, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 29.

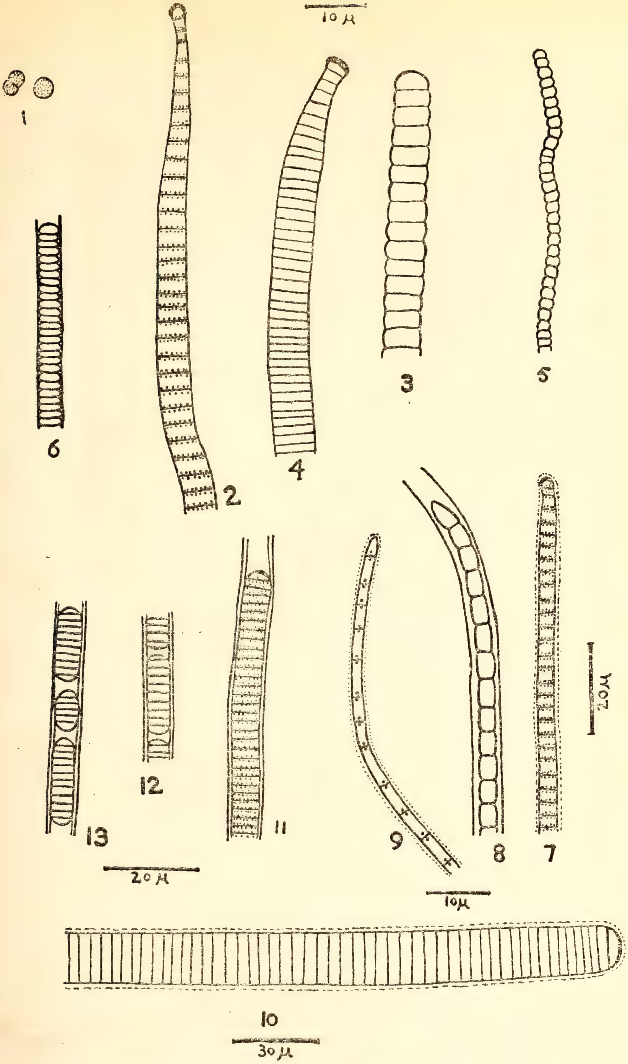

Fig. 1. *Synechocystis pevalekii* Erceg. : Showing a dividing cell and a single cell ; 2. *Oscillatoria amoena* Gom. var. *major* var. nov.: Showing a portion of the trichome ; 3. *Oscillatoria annae* Van Coor forma *minor* f. nov. : Showing a portion of the trichome ; 4. *Oscillatoria proboscidea* Gom. forma *hoshiarpurensis* f. nov. : Portion of the trichome showing the capitate and the calyptrate end cell ; 5. *Oscillatoria foreaui* Fremy forma *minor* f. nov. : Portion of a trichome ; 6. *Phormidium jenkelianum* Schmid forma *majus* f. nov. : Portion of the trichomes with sheath ; 7. *Phormidium favosum* Gom. var. *minus* var. nov. : Showing a portion of the filament ; 8. *Phormidium abronema* Skuja : Portion of a trichome ; 9. *Phormidium bigranulatum* Gardner forma *major* f. nov. : Portion of the filament ; 10. *Phormidium stagninum* Rao var. *robustum* var. nov. : Portion of the filament ; 11-13. *Phormidium hoshiarpurense* sp. nov. : 11. Portion of the filament ; 12-13. Portions of filaments showing hormogones

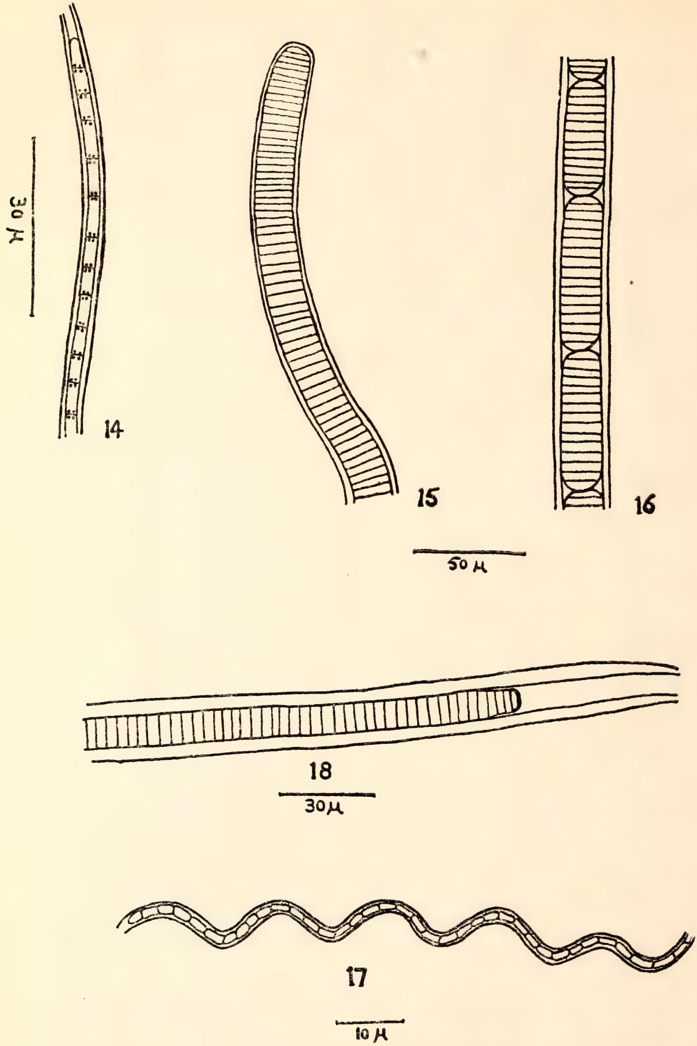

Fig. 14. *Phormidium valderianum* Gom. var. *minus* var. nov.: Portion of a filament; 15. *Phormidium anomalum* Rao var. *majus* var. nov.: Portion of the filament; 16. *Lyngbya truncicola* Ghose var. *hoshiarpurensis* var. nov.: Portion of a filament showing hormogones; 17. *Lyngbya lagerheimii* Gom.: Portion of a spirally coiled filament; 18. *Lyngbya nigra* Gom. var. *crassa* var. nov.: Portion of a filament showing calyptrate end cell.

The variety resembles the type in possessing: (*a*) unconstricted trichomes, (*b*) one or two granules on either side of each septum, (*c*) cells longer than broad, and (*d*) end cell rounded; but differs in the smaller dimensions of the trichomes.

36. **Phormidium anomalum** Rao var. **majus** var. nov. (Plate II, Fig. 15).

Filamenta curva, caeruleo-viridia, 15·3-17·2 μ lata; vagina distincta, hyalina; trichomata 12·1-16 μ lata, non-constricta; cellulae discoideae, 1·2-1·9 μ longae; cellula terminalis rotundata; calyptra nulla. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 30.

Filaments curved, blue-green, 15·3-17·2 μ broad; sheath distinct, hyaline; trichomes 12·1-16 μ broad, unconstricted; cells discoid, 1·2-1·9 μ long; end cell rounded; calyptra absent.

Habitat : In a stagnant water pond, railway road, Hoshiarpur. September 6, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 30.

The variety resembles the type in possessing discoid cells, end cell rounded and no calyptra; but differs in the greater dimensions of the trichomes.

LYNGBYA Agardh

37. **Lyngbya truncicola** Ghose in Jour. Linn. Soc. Bot. 46: 399, pl. 31, fig. 6, 1923; Desikachary 308, pl. 51, fig. 4, 1959.

Lat. filament = 12·4-19·2 μ; lat. trichome = 11·5-15·3 μ; long. cell = 3·8-4 μ; sheath yellowish brown; septa not granulated.

Habitat : On the bark of *Murraya exotica*, Hoshiarpur. August 17, 1960.

38. **Lyngbya truncicola** Ghose var. **hoshiarpurensis** var. nov. (Plate II, Fig. 16).

Thallus complanatus, caeruleo-viridis; filamenta recta, 16-23·1 μ lata; vagina luteolo-brunnea, distincta; trichomata non-constricta, 13·4-18 μ lata, non-attenuata; cellulae 3·4-4 μ longae, contentis granularibus; cellula terminalis rotundata; calyptra nulla. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 31.

Thallus expanded, blue-green; filaments straight, 16-23·1 μ broad; sheath yellowish brown, distinct; trichomes not constricted, 13·4-18 μ broad, not attenuated; cells 3·4-4 μ long, contents granular, end cell rounded; calyptra absent.

Habitat : On the trunks of *Mangifera indica*, Hoshiarpur. August 8, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 31.

The variety resembles the type in possessing : (*a*) filaments with yellowish brown sheath, (*b*) short cells without granulations at the septa, and (*c*) end cell rounded without calyptra ; but differs in the greater dimensions of filaments and trichomes.

39. **Lyngbya corticicola** Brühl et Biswas in Jour. Dept. Sci. Calcutta Univ. 5 : 9, pl. 4, fig. 13a-c, 1923 ; Desikachary 303, pl. 55, fig. 5, 1959.

Lat. filament = 19·2-22·8 μ ; lat. trichome = 12·1-15·3 μ ; long. cell = 3·8-5 μ ; crass. vag. = 2·7-3 μ ; septa not granulated.

Habitat : On tree trunks, Hoshiarpur. August 24, 1960.

40. **Lyngbya connectens** Brühl et Biswas, loc. cit. 5 : 4, pl. 2, fig. 8a-e, 1923 ; Desikachary 308, pl. 51, figs. 5, 6, 11, 1959.

Lat. filament = 18-19·2 μ ; lat. trichome = 16-17 μ ; long. cell = 2·7-3·8 μ ; septa granulated, contents granular.

Habitat : On tree trunks, Hoshiarpur. July 18, 1960.

41. **Lyngbya dendrobia** Brühl et Biswas, loc. cit. 5 : 8, pl. 3, fig. 11a-d, 1923 ; Desikachary 302, pl. 50, figs. 3, 10 and pl. 55, figs. 2-4, 1959.

Lat. filament = 11·5-12·1 μ ; lat. trichome = 9·5-11 μ ; long. cell = 3·8-7·6 μ ; trichomes slightly constricted ; contents granular ; septa not granulated.

Habitat : On the bark of *Zizyphus jujuba*, Hoshiarpur. August 18, 1960.

42. **Lyngbya aestuarii** Gomont var. **tenuis** Dixit in Proc. Indian Acad. Sci. B 3 : 104, 1936 ; Desikachary 308, 1959.

Lat. filament = 10·5-12·8 μ ; lat. trichome = 6·6-8·5 μ ; long. cell = 1·9-3·4 μ ; cross walls granulated.

Habitat : On the wet floor of an ice factory, Hoshiarpur. June 1, 1960.

43. **Lyngbya scotti** Fritsch in Nat. Hist. 6 : 29, pl. 2, figs. 91-93, 1912; Desikachary 310, 1959.

Lat. filament = 4·7-5·1 μ ; lat. trichome = 3-3·2 μ ; long. cell = 2·7-3·4 μ ; end cell conical, not capitate ; calyptra absent.

Habitat : On moist soil, Hoshiarpur. September 2, 1960.

44. **Lyngbya lagerheimii** Gomont, Mon. Oscill. 147, pl. 4, figs. 6, 7, 1892 ; Desikachary 290, pl. 48, fig. 6 and pl. 53, fig. 2, 1959 (Plate II, Fig. 17).

Lat. filament = 2·7-3·4 μ ; lat. trichome = 1·7-1·9 μ ; long. cell = 2·7-3·8 μ.

Habitat : Among other algae in a pond, Phagwara Road, Hoshiarpur. September 22, 1960.

45. **Lyngbya nigra** Ag. ex-Gomont. [Agardh, Syst. Alg. 312, 1824]; Gomont, loc. cit. 145, pl. 3, fig. 16, 1892 ; Desikachary 317, 1959.

Lat. filament = 15·3-16 μ ; lat. trichome = 8-9·5 μ ; long. cell = 3·8-4·7 μ ; end cell rounded with calyptra.

Habitat : On moist soil, Hoshiarpur. October 15, 1960.

46. **Lyngbya nigra** Gomont var. **crassa** var. nov. (Plate II, Fig. 18). Filamenta longa, recta vel curva, 17·2-23 μ lata ; vagina distincta, crassa ; trichomata attenuata ad apicem, non-constricta, 11-11·5 μ lata; cellulae 3·4-4 μ longae, contentis granularibus, septis indistinctis ; cellula terminalis rotundata ; calyptra adest. Positus in Government College, Hoshiarpur herbario sub numero *Vasishta* 32.

Filaments long, straight or curved, 17·2-23 μ broad ; sheath distinct, thick ; trichomes attenuated at the ends, not constricted, 11-11·5 μ broad ; cells 3·4-4 μ long, contents granular, septa indistinct ; end cell rounded ; calyptra present.

Habitat : On moist soil, Hoshiarpur. September 24, 1960. Deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 32.

The variety resembles the type in possessing : (*a*) unconstricted trichomes that are slightly attenuated at the ends, (*b*) sheath hyaline and unstained with chlor-zinc-iodide, (*c*) end cell rounded, and (*d*) calyptra present ; but differs from it in the greater dimensions of the filaments and the trichomes.

MICROCOLEUS Desmazieres

47. **Microcoleus acutissimus** Gardner in Mem. N. Y. Bot. Gdn. 7 : 55, pl. 11, fig. 2, 1927 ; Desikachary 344, pl. 60, fig. 1, 1959.

Lat. filament = 19·2-34·5 μ ; lat. trichome = 1·7-2·5 μ ; long. cell = 3·8-6·6 μ ; end cell acutely conical.

Habitat : On the moist steps of a tank at Una, Hoshiarpur. May 21, 1960.

Family NOSTOCACEAE Kützing

Subfamily ANABAENOIDAE

CYLINDROSPERMUM Kützing

48. **Cylindrospermum muscicola** Born. et Flah. var. **kasmiriense** Bharadwaja in Ann. Bot. Lond. 47 : 117, figs. 1-2, 1933 ; Desikachary 367, pl. 64, figs. 3, 5, 12, 1959.

Lat. trichome = 3·4-3·8 μ; long. cell = 3·8-7·6 μ; lat. heterocyst = 3·8-5·7 μ; long. heterocyst = 7·6-9·5 μ; lat. spore = 6·6-7·8 μ; long. spore = 9·5-15·3 μ.

Habitat : Along the sides of a stream at Dholbaha, Hoshiarpur. June 5, 1960.

NOSTOC Vaucher

49. **Nostoc linckia** [Bornet ex] Born. et Flah. var. **arvense** Rao in Proc. Indian Acad. Sci. B 6 : 358, fig. 4A, 1937; Desikachary 377, pl. 67, fig. 1, 1959.

Lat. trichome = 3·4-4 μ; long. cell = 3·8-5·7 μ; lat. heterocyst = 4-7·5 μ; long. heterocyst = 4-7·6 μ; lat. spore = 6·6-7·6 μ; long. spore = 6·6-8·5 μ.

Habitat : Forming blue-green patches on sandy soil submerged under water, Dholbaha, Hoshiarpur. June 5, 1960.

50. **Nostoc hataei** Dixit in Proc. Indian Acad. Sci. B 3 : 101, fig. 30, 1936; Desikachary 389, pl. 67, fig. 2, 1959.

Thallus gelatinous, hard, up to 2 cm. diam.; lat. trichome = 3·8-6·6 μ; long. cell = 3·8-5·7 μ; lat. heterocyst = 5·7-7·6 μ; long. heterocyst = 4·7-5·7 μ; spores not observed.

Habitat : On stones in running water near Una, Hoshiarpur. June 10, 1960.

ANABAENA Bory

51. **Anabaena volzii** Lemm. forma **recta** Kisselev in Acta Univers. Asiae Mediae, ser. 12a, Geographica Taschkent, fasc. 9, 74, pl. 1, fig. 1, 1931; Elenkin, Monog. Cyano. pars spec. 1 : 773, 1938; Desikachary 403, 1959.

Lat. trichome = 4-5·7 μ; lat. trichome at apex = 3·8 μ; long. cell = 8·5-15·3 μ; lat. heterocyst = 5·7-7·6 μ; long. heterocyst = 8·5-15.3 μ; lat. spore = 11·5-15.3 μ; long. spore = 34·5-46 μ; epispore smooth.

Habitat : Attached to water plants in a pond at Nasrala, Hoshiarpur. October 3, 1960. The form is reported for the first time from the Indian soil.

Subfamily AULOSIRAE Born. et Flah.

AULOSIRA Kirchner

52. **Aulosira aenigmatica** Fremy in Blumea Suppl. 2: 37, fig. 11, 1942; Desikachary 428, pl. 81, figs. 15, 17, 1959.

Lat. filament = 6·6-8·5 μ ; lat. trichome = 5·7-6·6 μ ; long. cell = 3·8-9·5 μ ; lat. heterocyst = 5·6-7·6 μ ; long. heterocyst = 7·6-8·5 μ ; lat. spore = 7·6-8·5 μ ; long. spore = 5·7-7·6 μ ; epispore yellowish brown in mature spores.

Habitat : In rice fields, Hoshiarpur. September 20, 1960.

Family SCYTONEMATACEAE Rabenhorst

TOLYPOTHRIX Kützing

53. **Tolypothrix byssoidea** [Berk.] Kirchner in Engler et Prantl, Naturlich. Pflanz. I, la : 80, 1900 ; Desikachary 502, pl. 103, figs. 3,4,7, 1959. *Hassalia byssoidea* Berk. in Hass. Brit. Freshw. Alg. 1 : 233, pl. 67, fig. 5, 1845.

Lat. filament = 12·1-15·3 μ ; lat. trichome = 10·5-11.5 μ ; long. cell = 3·8-5·7 μ ; lat. intercalary heterocyst = 12·7-14 μ ; long. intercalary heterocyst = 11·5-12·4 μ ; lat. basal heterocyst = 11·5-12·4 μ ; long. basal heterocyst = 7·6-8·5 μ ; trichomes torulose ; cells barrel-shaped ; spores not seen.

Habitat : On tree trunks, Hoshiarpur. August 19,1960.

SCYTONEMA Agardh

54. **Scytonema saleyeriense** Weber Van Bosse in Siboga Exped. 31, pl. 1, figs. 1-3, 1913 ; Desikachary 461, 1959.

Thallus brownish black or blue-green ; filaments 15·3-20 μ broad, false branches single or sometimes geminate ; sheath thick, lamellate, colourless, 3·8-4 μ thick ; trichomes 10-12·1 μ broad ; cells shorter than long, rarely quadratic, 6·6-8·5 μ long ; heterocysts intercalary, cylindrical or quadratic, 11·5-14 μ broad, 12·1-19·2 μ long.

Habitat : On moist walls, Government College, Hoshiarpur. August 13, 1960. The type is being recorded for the first time from India.

55. **Scytonema chiastum** Geitler in Pascher's Susswasserflora, 12 : 269, figs. 318-319, 1925 ; Kryptogamenflora, 750, figs. 478, 1932 ; Desikachary 453, pl. 90, fig. 1, 1959.

Thallus floccose, blue-green ; filaments long, straight or flexuous, up to 2 cm. long, 23-26·8 μ broad ; false branches usually geminate, rarely single, narrower than the main filament, up to 20 μ broad ; sheath thick, lamellated, colourless, yellowish brown in older filaments ; trichomes blue-green, 18·3-20·8 μ broad, blue-green, may or may not be constricted ; cells shorter than broad, 6·6-11·5 μ long ; heterocysts single or many together, rounded-quadrate, rarely spherical or sub-spherical, 19·2-21·1 μ broad, 18·3-26 μ long ; reproduction by hormogones.

Habitat : In rice fields, Hoshiarpur. September 21, 1960. The type is being recorded for the first time from the Indian soil.

56. **Scytonema pseudohofmanni** Bharadwaja in Rev. Algol. Paris, 7 : 167, fig. 4 E, F, 1934 ; Desikachary 478, pl. 94, fig. 2, 1959.

Lat. filament = 11·5-13·6 μ ; lat. trichome = 6·6-7·6 μ ; long. cell = 7·6-9·5 μ ; crass. vag. = 1·7-3 μ ; lat. heterocyst = 7·6-11·3 μ ; long. heterocyst = 7·6-15·3 μ.

Habitat : Forming dark brown patches on the sides of a hillock at Chak Saidu, Hoshiarpur. May 13, 1960.

Family RIVULARIACEAE Rabenhorst

RIVULARIA (Roth) Agardh

57. **Rivularia aquatica** De Wilde in Ann. Buitenz. 1 : 40, 1897 ; Desikachary 552, 1959.

Thallus spherical, blue-green, gelatinous, up to 4 mm. broad, without calcium incrustation ; filaments slightly adpressed, radially arranged ; sheath hyaline, thin ; trichomes 7·6-9·5 μ broad, ending in a hair which is 3·8 μ broad ; cells longer than broad at the base, up to 19·2 μ long, longer at the apex ; heterocysts spherical, single, basal, 10·5-12·1 μ diam. ; spores absent.

Habitat : Attached to submerged water plants in a pond at village Nasrala, Hoshiarpur. October 3, 1960.

GLOEOTRICHIA Agardh

58. **Gloeotrichia natans** [Rabenh. ex] Born. et Flah. [Rabenhorst, Kryptogamenflora, 90,1847] ; Born. et Flah. Nostoc. Heterocyst. 369, 1886 ; Desikachary 561, pl. 118, figs. 7, 15, 1959.

Lat. trichome = 7·6-9·5 μ ; long. cell = 5·7-13·4 μ ; diam. heterocyst = 11·5 μ ; lat. spore = 15·3-19·2 μ ; lat. spore with sheath = 31·5-34·4 μ ; long. spore = 40-76·8 μ ; sheath brown and transversely constricted.

Habitat : Attached to submerged plants in a roadside pond, Hoshiarpur. November 3, 1960.

The spores in the Hoshiarpur alga are less longer but the dimensions of other parts agree with the type. Transversely constricted sheath confirms its inclusion in *Gloeotrichia natans.*

Family MICROCHAETACEAE Lemmermann

MICROCHAETE Thuret

59. **Microchaete uberrima** Carter in Rec. Bot. Surv. India 9 : 268, pl. 1, figs. 1-3, 1926 ; Desikachary 511, pl. 104, figs. 5-7, 1959.

Long. filament = up to 4.5 mm.; lat. filament = 16·2-18 μ; lat. trichome = 12·4-13·2 μ; long. cell = 6·7-11·5 μ; crass. vag. = 1·9-2·5 μ; lat. heterocyst = 15·3 μ; long. heterocyst = 15·3 μ; lat. spore = 13·2-15·3 μ; long. spore = 13·2-23 μ.

Habitat: From the bottom of a pond, Village Purhiran, Hoshiarpur. September 15, 1959.

Order STIGONEMATALES Geitler

Family STIGONEMATACEAE Kirchner

HAPLOSIPHON Nägeli

60. **Haplosiphon intricatus** W. et G.S. West in Jour. Linn. Soc. Bot. Lond. 30:271, pl. 15, figs. 16-28, 1894; Desikachary 591, pl. 129, figs. 1-3, 1959.

Lat. main filament = 5·7-6·6 μ; lat. lateral branch = 5·7-6·6 μ; long. cell = 7·6-9·5 μ; lat. heterocyst = 5·7-6·6 μ; long. heterocyst = 8·5-15·3 μ.

Habitat: On the gelatinous thallus of *Aphanothece naegellii*, Hoshiarpur. August 28, 1960.

SYNOPSIS

The present communication incorporates records and descriptions of 60 species belonging to 21 genera. One new species, seven new varieties and five new forms have been included in this work.

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Marine Timber-Boring Organisms of the Indian Coast

Report on a Collection from the South-East Coast of India, with Notes on Distribution in the Indo-Pacific Area

BY

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INTRODUCTION

Earlier studies along the east and west coasts of India have shown that timber-boring animals cause extensive damage to all sorts of marine underwater structures made of timber (Nair 1961). Systematically, the timber-borers constitute a heterogeneous assemblage representing at least two phyla and eight genera in the Indian waters all sharing a common habitat and working together in the destruction of wood in sea-water, in brackish water, and even in fresh water. The phylum Mollusca is represented mainly by four genera, namely *Bankia, Nausitora,* and *Teredo,* which constitute the family Teredinidae or shipworms, and the genus *Martesia* of the family Pholadidae or piddocks. The crustacean wood-borers are mainly confined to the order Isopoda and are represented by the two well-known genera *Sphaeroma* and *Limnoria.* Four species and one variety of *Sphaeroma* and nine species of *Limnoria* have been reported from India. The amphipod borer *Chelura* has not yet been recorded from the Indian coast.

The nature of attack by the molluscs differs from that by the crustaceans and produces different effects on the timber, thus enabling them to share without serious competition a habitat which is limited in extent. While the crustaceans work from the outside, the molluscs penetrate deep into the heart of the timber. The combined action of the two groups of borers converts the wood into a highly porous, fragile, and honeycombed mass. The limnoriids even enter the creosoted shell of treated timber but the shipworm larvae seem unable to do this. As suggested by Menzies (1957), this may be due to the fact that teredines penetrate the wood as larval forms whereas the crustaceans penetrate the wood as adults. The shipworms are important destroyers of timber, since the growth of these highly specialised wood-borers is directly related to the damage they effect on timber and each shipworm during its lifetime destroys a column of wood of the same dimensions as itself. The piddocks are also equally important because of their wide distribution, density of attack, quick development, rapid succession of generations, and high tolerance of lower salinities (Nagabhushanam 1955). Even though the bore hole of the piddock is much smaller than that of the shipworm and does not usually exceed the size of the animal itself, the noteworthy feature is that each generation penetrates deeper and deeper, thereby considerably reducing the useful period of timber structures. Among the crustacean borers along the Indian coasts those of the genus *Sphaeroma* are the most important owing to their larger size, the burrow being about twice as large as the body, the high density of settlement, and the rapid rate of reproduction. Further, these crustaceans can also tolerate great reduction in the salinity of the medium which enables them to spread to the brackish waters. Three species are commonly met with in Indian waters, namely *S. terebrans*, *S. annandalei*, and *S. walkeri*. The genus *Limnoria* which is a very serious timber-borer in the higher latitudes is not a serious pest in Indian waters, even though nine species have so far been recorded (including those from Minicoy and the Andamans). They are *Limnoria pfefferi* Stebbing, *L. insulae* Menzies, *L. unicornis* Menzies, *L. platycauda* Menzies, *L. indica* Becker & Kampf, *L. bituberculata* Pillai, *L. tripunctata* Menzies, *L. septima* Barnard, and *L. bombayensis* Pillai. This small isopod is capable of effecting a progressive tunnelling action on wood and can make a burrow many times the length of its body. *Metaponorthus* and *Melita* have also been reported as capable of boring wood but are not serious pests.

Taxonomic studies have shown (Nair 1961) that at least 28 species of shipworms occur and are active in the Indian waters and constitute one of the most important and highly destructive timber borers along our coasts. They attack and destroy a wide variety of timber structures. It is probable that an extensive search of the wooden underwater structures along the Indian coast, the driftwood cast ashore during the monsoon, and particularly the water-logged timber that can be obtained by dredging would yield very valuable material which may expand this list still further. Several expeditions have reported the occurrence of remnants of plant material of land origin in deep water, particularly in the tropics, and the hauls from some parts of the deep sea are extraordinarily rich in different species of plant material and marine boring organisms. Such materials have neither been collected nor studied in any detail from the neighbourhood of India. The data would provide valuable material for understanding the nature, occurrence, distribution, and dispersal of wood borers in these waters. It is of interest to note that all the 17 species of *Xylophaga*, a wood-boring genus collected from the deep sea during the Galathea Expedition (Knudsen 1961), were new to science, which shows that the forms occurring in these habitats are quite different from those that occur in driftwood or in shallow waters.

Further most surveys of marine wood-boring organisms have been restricted to easily accessible sea-coasts and protected harbour areas, where test boards can be easily installed and examined as and when desired. Moreover, the destruction which these borers cause is chiefly detected on the harbour constructions, such as piers and wharves, which quickly attract the attention of harbour engineers and industrialists interested in waterfront structures. So our information about these pests is chiefly confined to their ecology near the narrow coastal zones and harbours. Their occurrence, distribution, relative abundance, conditions of life, and survival during the larval stages, soon after settlement on wood, and also the reproducing adult stages in the environment of the distant off-shore waters are all imperfectly understood.

A careful study of the reports from the east and west coasts of India and the neighbouring areas indicates that many of these wood-boring animals are widely distributed not only along the coasts of India but also in the Indo-Pacific area extending from the east African coasts, through Indonesia, to Samoa and Hawaii.

The present account is based on a collection of wood-boring animals made during December 1961 and February 1962 from two localities, namely Pamban on the Rameswaram Island and Keelakkarai near Ramnad on the south-east coast of India. It is hoped that this report, though not exhaustive, will be beneficial to zoologists, since this and adjacent areas particularly Krusadai are visited by a large number of scientists every year. The fauna of Krusadai studied in great detail for the last several years does not include a single shipworm.

WOOD-BORING MOLLUSCS

Family PHOLADIDAE

This family is represented by the Genus *Martesia* and two species are present in the collection, namely *Martesia striata* and *Martesia fragilis*.

Genus **Martesia** Sowerby

Subgenus **Martesia** Sowerby

1. **Martesia (Martesia) striata** (Linné)

1758. *Pholas striata* Linné, Syst. Nat. ed. **10** : 669.

Occurrence. Several specimens were collected from old piles (*Borassus flabellifer*) both from Pamban and Keelakkarai. Specimens (shells only) have also been collected from driftwood of the following species cast ashore, *Mangifera* sp., *Casuarina* sp., *Acacia* sp., *Bamboosa* sp.

Previous records from India. Madras, Porto-Novo, Tuticorin, Kayankulam (west coast), Cochin Harbour, Bombay, Visakhapatnam, Krishna estuary, and Krusadai.

Distribution. Eastern Pacific, Indo-Pacific, Western Atlantic.

2. **Martesia (Martesia) fragilis** Verrill & Bush

1890. *Martesia* (*Martesiella*) *fragilis* Verrill & Bush, *Proc. U. S. Nat. Mus.* **20** : 777.

Occurrence. Several specimens were obtained from a drift log (timber undetermined) cast ashore on Keelakkarai beach on 19 February 1964.

Previous records from India. Porto-Novo, Madras, Cochin.

Timber known to be attacked. *Myristica fragrans, Mangifera indica, Bamboosa* sp.

Distribution. Western Atlantic, Eastern Pacific.

Family TEREDINIDAE

This family includes the well-known shipworms and are the most important of the wood-borers collected. The genera *Bankia* and

Teredo are represented in the collection, the former by four species and the latter by eight species.

Genus **Bankia** Gray

Subgenus **Bankia** Gray

1. **Bankia (Bankia) bipalmulata** (Lamarck)

1801. *Teredo bipalmulata* Lamarck, Systéme des Animaux sans Vertébres: 129.

Occurrence. Three specimens were collected from a log of *Cedrela toona* cast ashore during December 1961 at Pamban. Dry shells and pallets have also been recovered from driftwood such as *Shorea* sp. and other as yet undetermined timber.

Previous records from India. Pondicherry, Madras, Kovilam.

Distribution. East African coast; Tanganika (Tanga); Sumatra (Babalan, Soeng Sang); Philippines (Mindoro); New Guinea (Manokwari); New Hebrides (Espiritu Santo); New Caledonia; Hawaii (Oahu).

Subgenus **Bankiella** Bartsch

2. **Bankia (Bankiella) indica** Nair

1954. *Bankia* (*Bankiella*) *indica* Nair, *Rec. Ind. Mus.* **52** : 393.

Occurrence. Several specimens were collected from a piece of driftwood cast ashore at Pamban.

Timber known to be attacked. Cedrela toona, Borassus flabellifer, Melia composita, Albizzia moluccana, Shorea robusta, Hopea sp.

Previous records from India. Madras, Adirampatnam, Cochin.

Distribution. Felix Roch (1961) feels that the form under consideration is probably a synonym of *Bankia carinata. B. carinata* has been recorded from the following places, namely Reunion, Malacca, the Sunda Islands, and New Guinea.

Subgenus **Neobankia** Bartsch

3. **Bankia (Neobankia) nordi** Moll

1935. *Bankia* (*Neobankia*) *nordi* Moll, *Sitz.-Ber. Akad. Wiss. Wien, Math.-Natw. Kl.* **1** (144): 272.

Occurrence. Two pallets were collected from the roots of *Pandanus* sp. cast ashore at Pamban.

Previous records from India. This is the first record of this species from India.

Distribution. Sumatra (Balawan Deli, Tandjoeng Balei); Singapore; Rhiouw Archipelago; New Guinea (Fak Fak).

Subgenus **Plumulella** Clench & Turner

4. **Bankia (Plumulella) lineata** Nair

1955. *Bankia* (*Neobankia*) *lineata* Nair, *J. Madras. Univ.* **25**B : 109.

Occurrence. Two specimens were collected from a log of *Cedrela toona* cast ashore at Pamban. Shells and pallets have also been recovered from driftwood (probably *Rhizophora* sp.) from the same locality.

Previous records from India. Madras, Visakhapatnam.

Genus **Teredo** Linné

Subgenus **Teredo** S. Str. Linné

5. **Teredo (Teredo) madrasensis** Nair

1954. *Teredo* (*Teredo*) *madrasensis* Nair, *Rec. Ind. Mus.* **52** : 401.

Occurrence. Several shells and pallets were obtained from pieces of driftwood cast ashore at Pamban.

Previous records from India. Madras, Kayankulam, Tondi, Adirampatnam.

Timber known to be attacked. Cedrela toona, Mangifera indica, Borassus flabellifer, Tectona grandis, Shorea sp., *Terminalia* sp.

Subgenus **Teredothyra** Bartsch

6. **Teredo (Teredothyra) indomalaica** Roch

1935. *Teredo* (*Teredothyra*) *indomalaica Roch, Sitz.-Ber. Akad. Wiss. Wien, Math.-Natw. Kl.* **1** (144) : 264.

Occurrence. Two pairs of pallets from a piece of driftwood (*Shorea* sp. ?) cast ashore at Pamban.

Previous records from India. Nil.

Distribution. Madagascar, Malacca, Singapore, Rhiouw Archipelago, Tandjoeng Penang, Sumatra (Oleh Lheue).

Subgenus **Lyrodus** Gould

7. **Teredo (Lyrodus) malaccana** Roch

1935. *Teredo* (*Lyrodus*) *malaccana* Roch, *Sitz.-Ber. Akad. Wiss. Wien., Math Natw. Kl.* **1** (144) : 269.

Occurrence. Several pairs of pallets were collected from pieces of driftwood (*Shorea* sp. ?, *Myristica fragrans, Bamboosa* sp.) at Pamban. A set of four live specimens were collected from the branch of a tree cast ashore at Keelakkarai.

Previous records from India. Visakhapatnam, Mandapam, Cochin, Bombay.

Distribution. Suez Canal (Ismailia), Aden, East African coast: Kenya (Mombasa), Tanganika (Tanga), Madagascar, Rhiouw Archipelago, Tandjoeng Penang, Singapore, Sumatra (Oleh Lheue, Belawan Deli), Java (Surabaja), Borneo (Kota Baru), New Guinea (Fak Fak).

Subgenus **Coeloteredo** Bartsch

8. **Teredo (Coeloteredo) singaporeana** Roch

1935. *Teredo (Coeloteredo) singaporeana* Roch, *Sitz.-Ber. Akad. Wiss. Wien, Math.-Natw. Kl.* **1** (144) : 266.

Occurrence. Four specimens were collected from the floating branch of a tree at Pamban.

Previous records from India. Visakhapatnam.

Distribution. East African coast: Kenya (Mombasa), Tanganika (Tanga, Pangani), Port Durban, Madagascar, Malacca, Singapore, Rhiouw Archipelago, Sumatra (Sabang, Emmahaven). Lombok (Ampenan).

9. **Teredo (Coeloteredo) renschi** Roch

1935. *Teredo (Coeloteredo) renschi* Roch, *Sitz.-Ber. Akad. Wiss. Wien., Math. Natw. Kl.* **1** (144) : 267.

Occurrence. Two specimens from the bark of a palm tree (*Borassus flabellifer*) cast ashore at Keelakkarai.

Previous records from India. Mandapam, Cochin.

Distribution. Rhiouw Archipelago, Singapore, Sumatra (Sabang), Java (Surabaja), Flores (Endeh).

Subgenus **Kuphus** Guettard

10. **Teredo (Kuphus) manni** Wright

1866. *Kuphus ? manni* Wright, *Trans. Linn. Soc. London* **25** : 565.

Occurrence. Two pallets were obtained from a piece of driftwood, *Tectona grandis*, cast ashore at Keelakkarai.

Previous records from India. Bombay, Visakhapatnam, Cochin.

Distribution. East African coast: Kenya (Mombasa), Tanganika (Tanga, Pangani), Mozambique (Mayotte, San Diego, Beira, Tongaland), Kerimba Islands, Madagascar, Reunion, Cochin China, Burma (Tavoy), Malacca, Singapore, Rhiouw Archipelago, Sumatra (Babalan, Belawan Deli, Pantai Tjermin, Soeng Sang, Langsa River), Tandjoeng Penang, Celebes (Moena), Moluccas (Amboina), Borneo (Kota Baru), Java (Surabaja), New Guinea (Fak Fak, Meranke, Hollandia Harbour, Seegarbui), Philippines (Luzon, Palawan), Bismarck Archipelago, Australia (Queensland).

Subgenus **Uperotus** Guettard

11. **Teredo (Uperotus) clava** Gmelin

1791. *Teredo clava* Gmelin, *Syst. Nat.*, ed. 13, : 3748.

Occurrence. Several specimens were collected from the floating seeds of mangrove from both Pamban and Keelakkarai.

Previous records from India. Madras, Karaikal, Pondicherry, Tranquebar.

Distribution. East African coast: Cape Province (Port Elizabeth), Natal, Mauritius, Ceylon, Java, Moluccas (Amboina), Philippines, Australia (Queensland, Sydney).

Subgenus **Dactyloteredo** Roch

12. **Teredo (Dactyloteredo) diederichseni** Roch

1929. *Teredo* (*Dactyloteredo*) *diederichseni* Roch, *Mitt. Zool. Staatsinst. Zool. Mus. Hamburg.* **44** : 6.

Occurrence. Several shells and pallets were collected from a big drift log (timber undetermined) cast ashore at Pamban.

Previous records from India. Madras, Cochin.

Distribution. Philippines, the Sunda Islands, Phoenix Islands (Canton), Midway Islands, Wake Islands, Hawaii Islands (Kuai, Oahu, Maui, Hilo, Johnston).

WOOD-BORING CRUSTACEANS

One species of *Limnoria* and two species of *Sphaeroma* are represented in the collection.

Family LIMNORIIDAE

Genus **Limnoria** Leach

Subgenus **Limnoria** Menzies

1. **Limnoria (Limnoria) indica** Becker & Kampf

1957. *Limoria* (*Limnoria*) *indica* Becker & Kampf, *Journal of the Timber Dryers and Preservers Association of India* **5** (1) : 12-17.

Occurrence. Six specimens were collected from green twigs cast ashore at Keelakkarai. All specimens were alive when collected.

Their burrows were shallow just beneath the bark of the twigs and the infestation was light.

Previous records from India. Mandapam camp, Madras Harbour.

Family SPHAEROMIDAE

Genus **Sphaeroma** Bosc

2. **Sphaeroma walkeri** Stebbing

1905. *Sphaeroma walkeri* Stebbing, *Ceylon Pearl Oyster Fishery Suppl. Rep.* **23** : 31.

Occurrence. Two specimens both in a dried condition were collected from a drift log cast ashore at Pamban.

Previous records from India. Neendakara near Quilon, Bombay, Madras, Visakhapatnam.

Distribution. Ceylon, Suez, Egypt, New South Wales, South Africa.

3. **Sphaeroma terebrans** Bate

1866. *Sphaeroma terebrans* Bate, *Ann. Mag. nat. Hist.* **3** (17) : 28.

Occurrence. Several specimens were collected in a dry condition from a large drift log cast ashore at Pamban.

Previous records from India. Backwaters of Travancore-Cochin, Madras, Mandapam, Bombay.

Distribution. Mediterranean, Mozambique, Zanzibar, North and South Africa, Ceylon, Queensland, Florida, and Brazil.

TABLE I

THE DISTRIBUTION OF SHIPWORMS

Name of shipworm	Pacific Ocean	Indian Ocean	Suez Canal	Red Sea	Mediterranean Sea	Atlantic Ocean	
Bankia bipalmulata	*	*	–	–	–	–	
Bankia indica	?	*	–	–	–	–	
Bankia nordi	–	*	–	–	–	–	
Bankia lineata	–	*	–	–	–	–	
Teredo indomalaica	–	*	–	–	–	–	
Teredo malaccana	–	*	*	–	–	–	
Teredo (diederichseni T. gregoryi)	*	*	–	–	–	–	
Teredo singaporeana	–	*	–	–	–	–	
Teredo renschi	–	*	–	–	–	–	
Teredo manni	*	*	–	–	–	–	
Teredo clava	*	*	–	–	–	–	

* present ; – absent

TABLE II
TIMBERS ATTACKED BY BORING MOLLUSCS

Name of timber	*Martesia striata*	*Martesia fragilis*	*Bankia bipalmulata*	*Bankia indica*	*Bankia lineata*	*Teredo madras-ensis*	*Teredo manni*	*Teredo indomalaica*	*Teredo malaccana*
Tectona grandis ..	–	–	–	–	–	*	*	–	–
Borassus flabellifer ..	*	–	–	*	–	*	–	–	–
Terminalia sp. ..	–	–	–	–	–	*	–	–	–
Myristica fragrans ..	–	*	–	–	–	*	–	–	*
Cedrela toona ..	–	–	*	*	*	*	–	–	–
Mangifera indica ..	*	*	–	–	–	*	–	–	–
Melia composita ..	–	–	–	*	–	–	–	–	–
Albizzia moluccana ..	–	–	–	*	–	–	–	–	–
Casuarina sp. ..	*	–	–	–	–	–	–	–	–
Pandanus sp. ..	–	–	–	–	–	–	–	–	–
Acacia sp. ..	*	–	–	–	–	–	–	–	–
Shorea robusta ..	–	–	*	*	–	*	–	*	*
Hopea sp. ..	–	–	–	*	–	–	–	–	–
Rhizophora sp. ..	–	–	–	–	*	–	–	*	–
Bamboosa sp. ..	*	*	–	–	–	–	–	–	–

* present ; – absent

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Reviews

1. THE WORLD OF THE TIGER. By Richard Perry. pp. xii+263 (22×15 cm.). London, 1964. Cassell & Co. Price 30*s*.

It gives one pleasure to read this book as, in the main, the subject has been well and accurately presented and developed, involving some research and investigation. But, in parts of the book accuracy has been interwoven with fantasy; this I feel must somewhat lower the worth of the work to readers with experience of the tiger in India, while no doubt enhancing its value to the majority of its readers.

The author observes in his introduction that the close of this century may see the end of the tiger in its wild state in India, except for a few in Sanctuaries and National Parks. In the first chapter he estimates that the number of tiger in India is now less than four thousand. I do not think there is much risk of the tiger disappearing from India within the next 36 to 40 years.

Nowadays the danger facing the tiger's existence in India is not so much the 'sportsman's' gun, even though more than 400 tigers are, we are told, still being shot annually. The threat lies in the activities of game poachers all over India. Even assuming there are only about 4000 tigers left in the sub-continent, which I consider an underestimate, and that some 50% of these are tigresses, the natural increase should suffice to keep the number well above the killings. The menace to the tiger's survival in India is the rapid extermination by poachers of its natural food, deer and pig, and the extension of cultivation into what are the tiger's domains. It is a provision of nature that as a predator's natural food supply decreases so does the size of its litters. Even so, the jungles covering the tiger's habitat are so vast, and parts of them so difficult of access to the poacher, that another 100 years or more should still find tiger ranging over large areas of forest.

The author is probably right in agreeing with Corbett that most man-eaters have become so 'by accident', in that this expression covers a wide field. For instance, a great increase in man-eating tigers was recorded soon after the Great Indian Famine, due no doubt to tigers feeding on the abandoned dead and dying all over the country-side. In fact, man-eaters became such a scourge, even in south India, that District Officers issued village headmen with phials of strychnine to be used on human and cattle kills. Some villages were abandoned in S. India and the man-eaters' victims included

Roman Catholic priests, pilgrims to temples and shrines, and travellers. Stone cairns, as described by the author, can be seen—as well as carved slabs depicting a hunter, or attacked man, driving a spear into a tiger.

The author observes that, though a tiger in India may kill during the day, it will not eat till after dark. This is usually the case, but the exception is not uncommon; indeed he gives instances of tiger in India eating in daylight.

Again a tiger's 'pooking' is, surely, a call of suspicion and uncertainty, far more likely to drive away sambar than to attract them.

While I do not claim that tiger have no sense of smell at all, I must disagree with the author's conclusions on this point. Tiger have a good 'hound' sense of smell, that is to say ground, and near-ground, scent. That a tiger can smell a putrid kill is surely no argument; so can we humans. A human can also smell tiger, gaur, sambar, and elephant on entering an area in which they have been shortly before. But this does not mean we can wind these animals from a distance; nor has it been my experience that tiger can. The tiger can see quite a distance in the dark, even on a 'pitch black night'; otherwise how does a tiger travel long distances, and that through heavy forest, on such nights?

The author refers to the failure of a tiger to return to its kill. Surely, one of the commonest causes is the removal of the kill by men of the low caste communities. This applies particularly to cattle kills. The tiger has learned from experience that it will find no kill. Colonies of these low caste people live outside most hamlets, and pay herdsmen for information about kills, and also for the victims' hides.

Are 'alligators' to be found in India? I think not; crocodiles, yes.

The author has been at pains to describe the habits of tiger, including man-eaters, and quotes at length from other writers' books. I am sure he realises that some of the incidents retailed are not necessarily related to facts; but, as I have observed at the outset, this may not affect the 'readable' value of the book.

R.C.M.

2. THE MOUNTAIN GORILLA. By George B. Schaller. pp. 431 (23·5×15·5 cm.). 35 Plates. Chicago, 1963. The University of Chicago Press. Price $ 10.

Since its discovery in the middle of the last century, the Gorilla has remained an object of fascination to man by its size, by its rather human appearance, and to its misfortune by the distortion of what little was known of it to present an animal of magnificent strength that apparently resented approach by twisting guns and mangling its human pursuers. Dr. Schaller's book, the first authentic and detailed study of the animal in the field, finally lays to rest the many misconceptions regarding a rather peaceful and solemn animal—a classic instance of 'a good story being spoilt by an eye witness'.

This remarkable book records the study of the ecology and behaviour of the Mountain Gorilla made by Dr. Schaller over a period of twenty months in its natural habitat in eastern Congo, western Uganda, and western Ruanda, primarily in the Virunga Volcanoes area. His only 'weapons' were a pair of binoculars and enormous patience. The difficulties of observing the animal in its natural habitat can be appreciated from the fact that he had only 466 hours of direct observation of the animal during the twenty months he was in the field. In this period of study he habituated six groups of the animals to his presence very near to them. The observations are described and analysed in the sequence of: Methods, Distribution and Ecology, the Animals, Population Density, Structure, and Behaviour, Responses to Environment, Conservation, Summary. Tables and Appendices on skull measurements, weather data, light readings, and an account of the original discovery of the Mountain Gorilla complete the text. The complete literature on the Mountain Gorilla, including an article in the *Journal of the Bombay Natural History Society*, is available in the Bibliography.

The picture of the animal that emerges from the study is of a peaceful and 'introverted' vegetarian living within a home range of 10 to 15 square miles in small family groups composed of a dominant silverback or fully adult male, other silverbacks and younger black-backed males in a linear hierarchy, and several females and young, leisurely foraging in the midst of an abundance of food (Dr. Schaller collected 100 species of plants used as food by the animal), building nests out of the undergrowth to rest in during the day and at night. It is a solemn animal that ceases to play at the age of six, living at peace with its environment. The 'beating of the chest' which has become so much a part of the Gorilla legend, though occasionally an act of intimidation, is usually a 'displacement activity', a release for tension comparable to the slamming of a door by an irate husband leaving the scene of a marital squabble.

In Dr. Schaller's opinion there is no immediate danger of the animal becoming extinct, though considerable inroads have been made into its habitat by agriculturists and pastoralists. One hopes that, in the present unsettled political conditions and the consequent availability of arms to persons who would not normally have them, the animal will not be one of the national assets sacrificed before stability is attained.

The book is an invaluable guide to those who wish to undertake such field studies which are a crying need in our country.

J.C.D.

3. THE CAMELLIA TREASURY. By Mrs. Paul Kincaid. pp. 224 (24×17 cm.). 16 colour and 88 monochrome plates. New York, 1964. Hearthside Press Inc. Price $ 9·95.

This well-illustrated book by a Camellia lover covers a very wide field including the history of Camellia growing, the Camellia in landscape gardening, cultivation in the open and in greenhouses, Bonsai, propagation, showing and flower arrangement. It is not possible to deal with all these subjects in much detail in a book of which the text is confined to about 210 pages. That is the book's chief failing—trying to deal with too much. However, some very useful information is contained in it, particularly in the chapter on propagation, making the book valuable for any gardener.

The Camellia, a native of China and Japan, has achieved a good deal of popularity in the United States, southern Europe, Australia, and New Zealand, apart from the countries of its origin. In the U.S.A. many Camellia societies exist. Northern Europe and northern North America are too cold for outdoor growing and the plains of India too hot. Yet, Mrs. Kincaid records that her plants have withstood a minimum temperature of 2° F. and a maximum of 106° F.

Speaking of the plant, which is not very well known in India, the author writes: 'The perfection of form, flower and foliage in the Camellia shrub is equalled by no other plant. Although much admired for its flowers—it would be an empress even for this one quality—the beauty of the plant in the landscape, and its aristocratic behaviour with a minimum of maintenance have given it exalted rank with many connoisseurs of the world's flora.' It is not surprising that this flower is very highly rated by flower arrangers, specially in Japan.

One half of the book is devoted to flower arrangements, and the majority of the photographs are of the author's own arrangements. The opinion of an expert on flower arrangement is that, here again, Mrs. Kincaid has attempted to cover too much ground. She deals with so many styles that the beginner will feel confused and be unable to learn any one of them with the help of this book.

Some of the arrangements in the photographs are very beautiful.

Mrs. Kincaid provides a list of 173 varieties of Camellias for outdoor growing, which she has grown in her own garden in North Carolina, and a further 25 varieties for greenhouse growing. Obviously, plant breeders have been at work on the Camellia. The colours produced are white, cream, light and deep pink to red and blackish crimson. Some varieties are striped, spotted, or edged with different colours. An orchid pink and a lavender pink are also mentioned.

In concluding, it is interesting to recall that the Camellia, a relative of tea, reached the West in a peculiar way. Some merchants in Britain ordered tea plants from China around 1720, as this drink was becoming very popular. The Chinese merchants, jealously guarding their monopoly, substituted Camellia plants, and thus this very popular ornamental reached Europe.

A.J.A.

4. ANIMAL POPULATIONS. By T. O. Browning. pp. 127 (19×12 cm.). London, 1963. Hutchinson & Co. Price 12*s.* 6*d.* (in U.K. only).

Occasionally one has the pleasure of reading a book that presents the subject with absolute clarity. This book is one among them. Dr. Browning, within the few pages of this slim volume, introduces the Ecology of Animals as a quantitative and experimental branch of science through the study of animal populations. To introduce the complex problems of the subject and to develop an understanding of the concepts, the first chapter describes in detail the ecology of the sheep tick *Ixodes ricinus* in Great Britain. The next two chapters deal with the concepts of populations and environment. The five categories of the latter, weather, resources, members of the same species, members of other species, and hazards are examined in detail and illustrated with examples in the five chapters that follow. The interaction of environmental factors and self-regulatory mechanisms are explained separately, and the book ends with a chapter on man's place in animal ecology and the ecology of man.

The book is exceedingly good as introductory reading and the list of references augments its value. To those interested in Natural

History, the book offers the methods to develop their interest into an exact science. Ecology is a subject which has very little following in India though the scope is vast, and it is hoped that there will be more emphasis in future on field studies of the type mentioned in the book.

J.C.D.

5. THE OXFORD BOOK OF BIRDS. Illustrations by Donald Watson. Text by Bruce Campbell. pp. xvi+207 (24×17 cm.). 96 colour plates and several black-and-white sketches. London, 1964. Oxford University Press. Price 35*s*. net.

Within the last year or two a spate of excellent and profusely illustrated bird books has appeared, and those with limited purses have to be choosy in their purchases. A glance at this book left me with no alternative. Every bird that has been authentically recorded in the British Isles is described, and about 320 different species are illustrated in colour; where the sexes differ, both the male and the female are shown, and also in many cases the immature plumages. In most cases the background of the picture depicts the kind of country where the species is to be found. This and the off-set printing completely remove the shiny 'glare' which is almost invariably present in books with coloured illustrations.

The text is apt and concise and relates to the species illustrated on the opposite page—in a few instances it is not easy to determine to which picture the caption applies.

A simple method has been devised to show at the end of the text relating to each species (a) the months during which it can be seen in Britain, (*b*) when eggs or young in the nest may be seen, and (*c*) when their songs may be heard, for instance:

. . *(3)* *4* **5** **6** **7** *8* *9* *10* *(11)* .

indicates a summer visitor which is not seen in January, February, and December, and only occasionally in March and November. Its song may be heard from April to July (underlined), and eggs and young found from May to July (in bold type).

A short introduction covers the different families, and the main external parts of a bird are illustrated. At the end, short chapters on Special Features of Bird Anatomy, Flight, Behaviour and Breeding, Migration, Numbers and Age, and Suggestions for Further Reading complete an exceptionally attractive book.

H.A.

6. A NEW DICTIONARY OF BIRDS. Edited by Sir A. Landsborough Thomson. pp. 928 (*c.* 25×18·5 cm.). 16 coloured plates, 48 pp. of photographs. London, 1964. Thos. Nelson & Sons Ltd. Price 105*s.* net.

One of the three special enterprises undertaken by the British Ornithologists' Union to celebrate its centenary in 1959 was the preparation of a comprehensive book of reference for everyone interested in birds throughout the world. This was also to be by way of tribute to Prof. Alfred Newton, F.R.S., who was one of the founders of the Union and author of A DICTIONARY OF BIRDS (1896). In spite of the revolutionary developments in the science of ornithology since that time, the old dictionary still remains a classic of ornithological literature and an indispensable reference for the serious bird student of today.

A NEW DICTIONARY is not merely a revised edition of the old. For one thing, unlike its prototype it is not the work of practically a single author but represents the contributions of some 200 of the world's foremost ornithologists, many of whom are specialists in their own fields.

As the Editorial Introduction explains, the aim of the book is to provide authoritative information to the ornithologist outside his restricted field of specialization, to the biologist who wishes to draw upon the specialized subject matter of ornithology, as well as to the more serious non-professional lover of birds. How admirably it fulfils this aim and purpose will be obvious to everyone who turns over its pages. The information provided is of two kinds: (*a*) on general subjects relating to birds as a Class, and (*b*) on the different kinds of birds according to families.

Under General Subjects come topics like Morphology, Systematics and Evolution, Distribution and Ecology, Ethology (Behaviour), Birds and Man. A separate list of the major articles on general subjects is given in order 'to indicate the entries most suitable for deliberate reading as distinct from quick reference on occasion'. To give an example, under Distribution and Ecology the following topics are mentioned: **Distribution**: Geographical Distribution, Palaearctic Region, Ethiopian Region, Malagasy Region, Oriental Region, Australian Region, Nearctic Region, Neotropical Region, Oceanic Birds, Antarctic, Range Expansion, Mapping. **Migration**: Migration, Irruption, Navigation, Moon Watching, Radar, Observatory, Ringing, Trapping. **Environmental Influences**: Climatology, Meteorology, Geological Factors, Vegetation. **Ecology and Populations**: Ecology, Breeding Season, Predation, Numbers, Census, Count, Population Dynamics, Expectation of Life, Palatability of Birds and Eggs, Pollinators and Distributors. **Parasites and Diseases**: Ectoparasite, Endoparasite, Disease.

Many of the major articles are of encyclopaedia length and, together with the copious cross references and the selected bibliography given at the end of each, they furnish sufficiently adequate information on the topic concerned. The task of editing, moderating, reconciling, and cross-referring this vast mass of heterogeneous material received from nearly 200 individual contributors, in addition to much else from the editor's own pen, must have been truly stupendous and formidable. Few others could have undertaken the responsibility and discharged it with such dedication and masterly skill as Sir A. Landsborough Thomson—himself one of the world's outstanding ornithologists. An old Arab proverb deplores how seldom the Time, the Place, and the Loved One can all be found together. Metaphorically speaking, here without doubt is one of those rare occasions. The BOU and all those who will be using this admirable book have indeed cause to be grateful for the finding of the right man in the right place at the right time. All the circumstances have combined and conspired to produce a work that will certainly stand out as the bird book of the century and will still remain a classic in the centuries to come. It is a fitting memorial to the editor, to the contributors, to ornithology itself in general, and to the BOU in particular the centenary of whose birth it is meant to celebrate. Last but not least, it must be mentioned that the royalties accruing to the Union from the sales of the book have been ear-marked as the nucleus of an endowment fund for the furtherance of ornithological research and for special publications.

S.A.

7. AN INTRODUCTION TO THE MAMMALS OF SABAH.

By John Harrison. pp. 244 (*c.* 18 × 12 cm.). Illustrated by Chong Yus Fatt. Jesselton, 1946. The Sabah Society.

It took me some time to ascertain that Sabah is what used to be known as British North Borneo. The latter name, however, brings back to mind the postage stamps depicting the tapir and rhinoceros, and forming, perhaps, my first introduction to natural history.

The paperback form appeared hardly compatible with the title, but the author's name and a glance at the contents were reassuring. While it is hardly possible to provide notes for the field identification of 56 species of bats, 11 flying squirrels, and 19 squirrels, the excellent keys, short descriptions, and drawings will be of great value to all who are interested.

Such a book covering Indian mammals is badly wanted. Curiously, the price is not mentioned[1].

H.A.

8. THE WORLD OF BIRDS : A Comprehensive Guide to General Ornithology. By James Fisher and Roger Tory Peterson. pp. 288 (*c.* 31×24 cm.). With bird paintings by Roger Tory Peterson. London, 1964. Macdonald. Price £5.5.0 net.

According to the authors' own estimates the total number of full species of living birds today is 8580. They add a further 937 species known from fossils or which have become extinct in the last 350 years. Of this total of 9517 nearly 1200 species are mentioned and 743 illustrated in this book—668 in colour—with the consummate skill and mastery of Roger Tory Peterson.

The authors are big names in ornithology today and a book like this embodying their joint labours and individual skills and erudition is something of an event. It is one in the line of large, lavishly illustrated, and somewhat expensive bird books whose proliferation in recent years is a sure and refreshing sign of the growing popularity bird study has achieved—and largely through the agency of such illustrated books themselves. Not long ago we had Gilliard's magnificent LIVING BIRDS OF THE WORLD. This was soon followed by Austin's BIRDS OF THE WORLD and now we have this equally magnificent THE WORLD OF BIRDS. They may well be called the Bird and World series, and one may well wonder what other permutations the words will still admit!

The book covers such a vast range of topics that it is not possible to give an adequate idea of the contents within the limits of a short notice. Much of the recent scientific investigations, findings, trends, and hypotheses are described in language which should make them readily comprehensible to the interested layman. The variety of birds, their evolution, attributes and specializations, their distribution, abundance, migrations, social life, food, and behaviour are discussed. The authors believe that 'the total bird population of the world, including sea birds, may be of the order of a hundred billion' (=a hundred thousand million).

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[1] From a book news sheet issued by Borneo Literature Bureau the price has been ascertained to be M$ 4,00.—EDS.

There is a useful chapter on 'Bird Watching' with hints for observing, note-taking, and record-keeping, and helpful suggestions concerning equipment such as field glasses, blinds (or 'hides'), still and movie cameras, lenses, and other gadgets for bird photography and sound recording. Another chapter describes the techniques of modern bird migration study—netting, trapping, and ringing; and moon watching, and radar. How birds can be attracted by the provision of nest-boxes and feeding trays, and Bird Protection and Bird Sanctuaries forms the subject of another section. Many other topics such as chemical sprays and insecticides and the menace of oil pollution of the sea also find their place. The chapter entitled 'The Regiment of Birds' (covering about 100 pages) of attractively designed distribution maps for all the 199 Families—fossil, recently extinct, and living—together with lists of the genera, number of known species, and probable centre of origin of each is a novel and very useful feature. The families are headed by RTP's beautiful silhouettes of one of its typical representatives. The chapter 'Birds and Men' is of particular interest as it deals with various aspects of economic ornithology showing the debit and credit sides of its balance sheet with man. The book concludes with a 'RED LIST' showing family by family the birds presently in danger of extinction and needing special protection, and a 'Black List' showing all the species known to have become extinct since about 1600 A.D. The good bibliography, sectioned into Fossil Birds, General and Introductory, Special aspects of Natural History, and Selected standard bird books region- and country-wise, will be invaluable for reference.

The book is certainly, as its publishers claim, 'unique in many ways', both the illustrations, and the letterpress make it so. And to this it must be added that the layout and printing are superb.

S.A.

9. NEVER CRY WOLF. By Farley Mowat. pp. 247 (22 × 14 cm.). Boston, 1963. Atlantic Monthly Press, U.S.A. Price $ 4·95.

From his earliest youth, Farley Mowat was drawn to the study of animals in their habitat. It was natural therefore that one day he received a summons from the Dominion Wildlife Service to investigate the *Canis lupus* problem which had assumed national importance. Thirty-seven memoranda had been received from members of the Canadian House of Commons expressing the concern of their constituents about the menace they faced from wolves. It was reported that wolves were killing all the deer and caribou, and the suggestion that human hunters were responsible for the killing had been hooted down as emanating from wolf lovers. A full-scale investigation was therefore deemed desirable.

When Mowat arrived at Churchill on the western shore of Hudson Bay *en route* to his ultimate destination in the desolate wastes of the subarctic barren lands, he had to follow this soulless operational order: 'You will, immediately upon reaching Churchill, proceed by chartered air transport in a suitable direction to the requisite distance and thereupon establish a base at a point where conditions generally are optimal to the furtherance of your operations.'

He reached his destination by chartered plane, with equipment and stores to last him for more than a year. It must require extraordinary courage and resourcefulness to face the prospect of life in an uninhabited tundra without human company for months together. It must also require unusual dedication to one's ideals to follow this part of the operational order: 'Immediately after establishing a permanent base you will proceed, by means of canoe and utilizing waterways, to make an extensive general survey of the surrounding country to a depth, and in a manner, which will be significant in statistical terms, in order to determine the range/population ratio of *Canis lupus* and in order to establish contact with the study species'.

By a stroke of luck an Eskimo happened to come along with his huskies where the author landed. He had a cabin of Caribou hide not far from this place, and the author grasped the opportunity to house himself and his valuable equipment in the cabin. He then got to work on his problem.

Mowat was an ideal investigator for the job for he seemed to have no preconceived notions about the wolf/caribou relationship. On his first tour around his cabin he found four or five hundred caribou skeletons. He assumed that these beasts had been killed by wolves. Later, however, he saw that the density of caribou remains decreased in geometrical ratio to the distance from human habitation. This problem was certainly worth investigation, and by the time he had finished he came to some startling conclusions.

Fortunately, the author discovered a wolf den not far from his cabin. It consisted of a couple, whom he named George and Angeline, and an unattached general factotum of the establishment, whom he called Uncle Albert. The book is a gripping account of the life of this family and the four pups. While the pups were being nursed Angeline came to the door of the den, to bid good-bye to George and Albert every night when they left for the hunt. They returned the next morning worn out by the chase. They never came back with anything in their mouths, and the author discovered that the pups were fed by regurgitation. After the pups had grown up Angeline also joined in the hunt. When caribous were not available, the wolves lived on mice which were plentiful in the area. The author lived on an exclusively mice diet for several days to check on its food value. The relationships between the adults and the young have been described charmingly and scientifically. Mowat is an experienced and gifted writer and he presents his observations in a manner which make them unforgettable.

The opinions of human beings about the viciousness and brutality of wild animals have been proved wrong again and again. In the case of the wolf the author was able to prove conclusively that they kill only for food, and waste very little of what they kill. They concentrate on killing the weak and unhealthy caribou, thereby aiding the maintenance of healthy caribou stock. The numbers of wolves were nowhere as large as was presumed, because each wolf family requires a large area in which to hunt and live. The decimation of caribou herds was not due to the depredation of wolves but to barbarous killings by trappers who kill several hundred at a time and to 'sportsmen' who are given the opportunity by Safari Companies to corner the herds with planes and shoot the trapped animals as they scamper over the frozen lakes. The hypocrisy of the human race with regard to their attitude towards wild life is exposed unanswerably in this book, and the epilogue, reproduced below, makes distressing reading: 'During the winter of 1958-1959 the Canadian Wildlife Service, in pursuance of its continuing policy of wolf control, employed several Predator Control Officers to patrol the Keewatin Barrens in ski-equipped aircraft for the purpose of setting out poison bait stations. In early May of 1959, one of these officers landed at Wolf House Bay. He remained in the vicinity for some hours and placed a number of cyanide 'wolf getters' in appropriate places near the den, which, so he ascertained, was occupied [This den, incidentally, was the one which had been occupied by Angeline and her family]. He also spread a number of strychnine-treated baits in the vicinity. He was unable to return at a later date to check on this control station, because of the early onset of the spring thaws. It is not known what results were obtained.'

Z.F.

10. CALL OF THE TIGER. By Lt.-Col. M. M. Ismail. pp. 174 (20·5×13·5 cm.). London, 1964. Faber and Faber. Price 18*s*. net.

Crime stories are usually written, read, and enjoyed by those who are not concerned with crime or its detection, and in recent years a large number of tiger and other shikar books have been produced on the same lines.

This book however is refreshingly different. The author is one of the old brigade, who were prepared to work hard in the forests and pit their wits against the animals on relatively equal terms.

There are no heroics or tales of massacre. The reader quietly, but often tensely, accompanies him on his excursions. All the ventures do not produce adventures, nor are all successful, as is true in real life. But the stories, with their background of natural history and shikar knowledge, hold your attention, and are no less interesting than those in which five shots are placed in the heart of the charging tiger.

Col. Ismail's book has the correct perspective. He obviously knows his subject, and every true sportsman and lover of nature will enjoy it—my only objection is to his 'maneaters': in the book at least, I would prefer 'man-eaters'!

In connection with the continued decline in the number of our larger animals, he has referred to arms-licences in the erstwhile Bombay State increasing from 70,000 to 1,20,000, in which the number of crop-protection licences rose from 20,000 to 70,000 leaving those for sport unchanged at 50,000. It may be interesting to add that hardly a thousand (2%) of these 'sportsmen' apply for game licences every year! The holding of Wild Life Weeks does not help. Together with the resolutions of Wild Life Boards and such bodies, they only serve to divert attention from the real problem, and apparently to satisfy those who do not know the actual position out-of-doors but talk about it and minute pious resolutions.

H.A.

Miscellaneous Notes

1. HABITS OF THE RHESUS MACAQUE *MACACA MULATTA* (ZIMMERMANN) IN THE SUNDERBANS, 24-PARGANAS, WEST BENGAL

The habits of the Rhesus macaque in the Sunderbans have not yet been recorded. In the course of faunistic surveys conducted during the years 1955-1960 A.K.M. had the opportunity of studying the habits of this monkey which appear to differ from its habits in other parts of West Bengal.

In the extensive mangrove forests of the Sunderbans, which thrive in the numerous swamp deltas facing the Bay of Bengal, the Rhesus has established itself under conditions normally unfavourable to Primate life, namely the absence of fresh water, the submergence of the greater parts of the islands in the spring tides, the soft, muddy, and slippery soil, cyclonic conditions especially during the summer and monsoon, etc. Its predators are terrestrial, arboreal, and aquatic, e.g. the Tiger (*Panthera tigris*), the Python (*Python molurus*), the Estuarine Crocodile (*Crocodilus porosus*), and sharks, which include the Wolf Shark (*Alopynus vulpinus*) and the Man-eating Shark (*Carcharinus gangeticus).*

Observations were made in the low mangrove forests [Forest type 1 S/2 (a) of Champion (1936, p. 103)], mostly in the Basirhat Reserve Forest in Arbesi, Jhilla, Harinbhanga, Khatuajhuri, and other adjoining forest blocks along the East Pakistan border. The population of the Rhesus appeared to decrease from east to west.

The troupes consist of 20 to 30 individuals. Solitary individuals are also noticed. They are not very common, and perhaps represent exiled males. Each troupe occupies a territory, generally a complete forest block in an island, but in large islands there are more than one troupe. They are shy and avoid human approach by moving away into the deeper parts of the forests, and never show any aggressive attitude. They are almost entirely arboreal, rarely descending to the ground except during cyclonic weather, when they take shelter in long grass or under Hental (*Phoenix paludosa*) palms and sometimes on the lower branches of large trees. They avoid swimming in the saline backwater. However, in search of food, some are found to move on mud-flats and sometimes a troupe may boldly swim across creeks at ebb tide and move into the nearest reclaimed area to feed on standing crops. Their food in the forest consists of the pods, leaves, and fruit of Garjan (*Rhizophora conjugata*), Goran (*Ceriops* spp.), Golpata (*Nipa fruticans*), Baen (*Avicennia alba*), Bhaila (*Afzelia bijuga*), Gengwa (*Excaecaria agallocha*), etc. The fruit and leaves of Keora (*Sonneratia apetala*), however, constitute the principal fodder for the monkeys, and are shared with Spotted Deer (*Axis axis*), which feed on the leaves and fruits dropped by the monkeys. Further, their vigilance and alarm calls save the deer from predators. We have found the monkeys eating crabs, which are commonly seen in the puddles of water during the ebb tide. We have not seen them catching fish, although local fishermen report that they catch fish. Mushrooms are also included in their menu. Water is obtained by licking dew deposited on leaves, and by eating succulent leathery leaves and long juicy grasses growing on the river flats.

The taxonomic status of the Sunderban Rhesus is not definite. Anderson (1872) referred to a specimen from the Sunderbans as a supposed new monkey, and Khajuria (1954, p. 113) while listing them under the nominate race pointed out that they differ in texture and coloration. The authors observed that in life the Rhesus in the Sunderbans is duller as compared with those from other parts of West Bengal. The orange-red fur on its loins and rump is rather inconspicuous.

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA 13,
September 15, 1964.

AJIT KUMAR MUKHERJEE
SUMIT GUPTA

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2. WILD DOGS (*CUON ALPINUS*) AND VILLAGE DOGS

We reached our land by Sigur River in the lower plateau of the Nilgiris late in the evening on 31-10-1964. There was a herd of cheetal about 100 yards away. Seeing us they stopped grazing and looked at the car curiously in typical cheetal fashion. As we were watching them from the car, three sambar hinds made their appearance. They were trotting looking behind every now and then. Soon a fawn came into view and, on its trail, a pack of dogs—two wild dogs in front, then two pi-dogs, and behind them following at a leisurely pace half a dozen wild dogs. The leading dogs were closing in when I decided to intervene.

The cheetal had fled by this time, but the mother sambar stopped and the fawn took shelter by its mother's side. The other two hinds halted a few paces away and looked on. When the two wild dogs rushed to seize the fawn its mother, who could have used her fore feet with effect, did nothing of the kind but walked up to meet the attack with out-stretched neck, as if to say 'Take me, but please leave the kid alone'.

By this time I was within effective shot gun range, and one wild dog seeing me turned and ran to join its companions which were standing some distance away watching me. The other was quite oblivious of my presence. The pi-dogs dashed about barking and trying to help in the hunt. Holding my shot till I got a chance, I fired at the wild dog. It fell, got up, and ran towards the jungle.

At the report all the wild creatures except the fawn dispersed, but the pi-dogs rushed in to the attack. They knocked the fawn down and worried it, but a few well-aimed stones made them let go. I went up to the fawn which was wet and shivering but otherwise unhurt. My wife and daughter joined me and we stood it on its feet and massaged it. It became quite frisky after a while and we let it go to join its family, while I stood by to keep the dogs from having another try.

The pi-dogs also went away after some time. But I doubt if they re-joined the wild dog pack as it had become quite dark by then. As it rained heavily throughout the night I could not recover the wounded dog.

The wild dogs did not seem to object to the two pi-dogs joining in the hunt. But would they have accepted the pi-dogs at the 'kill'?

Whether the pi-dogs, which we discovered later to belong to neighbouring *patti* (cattle kraal), joined in the middle of the hunt or were with the wild dog pack right from the start I am unable to say. They certainly did not join near the end of the hunt, for when we passed the *patti* on our way to our land the dogs were not there.

On 13-12-1964, in the same locality, I came across another instance of wild dogs and village dogs hunting together. It was about 3 in the afternoon when we heard a scream from the river. It sounded like a dog in distress. The scream was repeated and I ran towards it. Half way, I met some men, one of them a Game Watcher of the Nilgiri Wild Life Association, and they told me that a wild dog and a pi-dog were attacking a sambar fawn and it was the deer that was making the noise.

When I got to the spot, the young deer was in the middle of a pool and the pi-dog standing guard on a rock projecting into the pool. The wild dog had decamped. On seeing us, the fawn attempted to get out, but the dog jumped in and attacked. When it tried to seize the fawn a second time, I shot it dead. The fawn had a raw patch on the inside of its right hind thigh but was otherwise all right and limped away. It was a little bigger than the first fawn we rescued and was probably the same animal!

The Game Watcher told me that he has seen wild dogs and village dogs hunting together, but once the kill is made the wild dogs take complete charge and only after they have had their fill are the pi-dogs permitted anywhere near the kill.

On 1-1-1964 a friend and I saw and photographed some wild dogs on the banks of the Moyar hydro-electric channel about 5 miles away from the scene of action described above. One of the dogs had a distinct white patch of hair on its throat, indicating mixed blood. It would be interesting to observe whether the wild dogs mate with their domesticated brethren.

THE NILGIRI WILD LIFE ASSOCIATION,
OOTACAMUND, S. INDIA, E. R. C. DAVIDAR
December 23, 1964.

[Cases of association between wild dogs and pariah dogs have been reported previously (e.g., 1951, *J. Bombay nat. Hist. Soc.* **50** : 163). It would be interesting to have particulars of known cases of interbreeding.—EDS.]

3. BREEDING OF THE INDIAN WILD ASS *EQUUS HEMIONUS KHUR* LESSON IN CAPTIVITY

I write to report the birth of an Indian Wild Ass, *Equus hemionus khur* Lesson, 1827, on 13 August 1964, in the Maharaja Fatesingh Zoo at Baroda. As you are aware, this species is on the list of rare animals, and I believe has never been bred in captivity. I am informing you of this as I am sure the Society will be interested.

LAXMI VILAS PALACE,
BARODA,
October 5, 1964.

F. GAEKWAD,
Maharaja of Baroda

[Harper in EXTINCT AND VANISHING MAMMALS OF THE OLD WORLD states that, between 1842 and 1849, 9 Wild Ass foals were born in the Paris Zoo. There is no record of the species breeding in captivity in India.—EDS.]

4. THE HISPID HARE [*CAPROLAGUS HISPIDUS* (PEARSON)]

In continuation of the Editorial Note (*Journal* **57**:400-402) on the rarity of the Hispid Hare, Shebbeare (*Journal* **58** : 266-267) reported that it was not uncommon in parts of the Goalpara Forest Division in 1907-1911. During March-April, 1955 and 1957, the writer collected for about seven weeks around Raimona and Jamduar in the north-eastern parts of Goalpara District, Assam, bordering West Bengal and Bhutan. The species is certainly rare in this area at present because, despite the best efforts of four trained collectors to make a thorough survey of the mammalian fauna of the area, I could see only two specimens, one in the field (not collected) and a young one with a local person who had obtained it around Raimona. The young one was purchased by the leader of the German-Indian Expedition with whom the writer was then working and is now in the collection of the Hamburg Museum. The one seen in the field was seen at dusk near a shallow pool of water just on the left bank of Sankosh River about 3 km. south of Jamduar Forest Rest House. On noticing the presence of the writer at a distance of hardly 15 metres it ran away, then stopped and tried to hide itself behind stones, but finding itself too big to do so it ran up a high bank and disappeared in the bush. On inspection of the spot where it had disappeared a fresh burrow large enough to accommodate the animal was noticed. It was excavated on the top of the alluvial bank, partly below a bush about ten metres from the pool of water. The bank was well covered with tall grass and some bushes and bordered at some distance by a typical sal forest. The area was far removed from human habitation and showed numerous footprints of large and small carnivores, deer, and several other wild animals. The spot was again visited at the same hour next day but the animal was not seen.

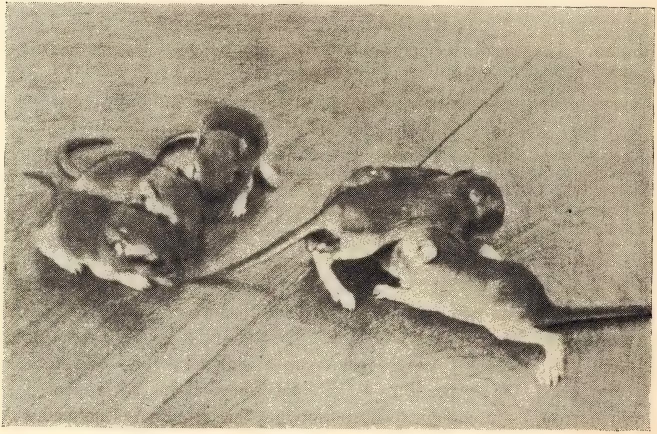
CENTRAL REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JABALPUR,
July 20, 1964.

H. KHAJURIA

5. YOUNG OF THE INDIAN GERBILLE, *TATERA INDICA INDICA* HARDWICKE

(*With a photograph*)

A brood of six young (4 ♀♀ and 2 ♂♂) of the Indian Gerbille *Tatera indica indica* Hardwicke, each weighing 25 gm., was taken on 20-11-63 by the writer from a burrow at village Manot on Mandla-Dindori Road, Madhya Pradesh. The mother escaped. They were still blind but were well covered with hair. The following unrecorded differences from the adults, two of which were also collected from the same locality, have been noted.



Young of the Indian Gerbille, *Tatera indica indica* Hardwicke

Photo : *H. Khajuria*

Hair growth is imperfect around the urinogenital organs, the inner side of the thigh, the chest, the throat, the inner side of the front legs, and the lips. The upper portion of the snout in front of the black patch is almost hairless. There is a large hairless patch behind the ears which in the adult is covered over by white hairs. The black spots on the snout, around the eyes, behind the ears, and behind the ankles are comparatively larger and darker. There is a prominent white patch above the eye extending almost to the ear and a smaller one below it. The ears, especially their posterior aspect, are much more hairy. The whiskers are all white and comparatively longer. The pencil of long black hairs at the tip of the tail, a characteristic of the adult, is absent. The lateral light-coloured streaks on the tail are shorter. The light rufous and grey patches on the anterior side of the front leg are more pronounced. The soles of the feet are much lighter but the pads are darker. The tail is less hairy. There is very little individual variation except that the lateral lighter streaks on the tail may be shorter or longer, and the light rufous patch on the upper parts of the front leg may be absent.

The clitoris is nearly as large as the penis. Since the testes are not visible and the urinogenital opening is almost invisible to the naked eye, sex determination is difficult.

As shown by the measurements given below the proportions of their body parts are different from those of the adults collected from the same locality in the same season:

No. & description	Head & Body	Ear	Hind Foot	Tail
	Measurements in mm. with mean values in parentheses			
6 young	67-75	9.5-11	23.5 25.00	62-66
	(69.8)	(10)	(24.33)	(64.8)
1 Adult	196	24	40	210·8
	Measurements as percentages of hind foot			
6 young	286·9	41.1	—	266.3
1 Adult	490	60	—	527

CENTRAL REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JABALPUR,
April 24, 1964.

H. KHAJURIA

6. SOME NOTES ON THE PAINTED PARTRIDGE [*FRANCOLINUS PICTUS* (JARDINE & SELBY)] AROUND BOMBAY : A CORRECTION

In the last issue of the *Journal* (**61** : 447) I said that the Painted Partridge [*Francolinus pictus* (Jardine & Selby)] calls only during the courting and breeding seasons, and gave the first and last dates as 8th April and 5th November. While waiting for duck at dusk at Ghoti, Nasik District, Maharashtra, on 25th December 1964, I thought I heard a Painted Partridge call but was not quite sure.

On the following day we were driving back from Nasik in the late afternoon to get into position for the evening flight (at Lake Beale) when we ran out of petrol some 10 miles from Ghoti. Half an hour after sunset, while still waiting for petrol and thinking of all the duck that had escaped, we heard a Painted Partridge call some distance from the road and a reply from far away. Jamshed Panday and I walked towards the calling bird and kicked about the bushes, but no bird was seen. As we walked back to the car almost in the dark, a bird rose from the grass at our feet and was dropped and collected. It was a male in non-breeding condition. On the following day we worked the area and got 3 more birds all with undeveloped gonads.

I also find the following in my notes made at Vidishi, Sironj (old Tonk State), Madhya Pradesh, on 18 December 1958: 'In the evening the Grey Partridge were calling all around. A few Painted Partridge joined in later and continued after sunset, when the Grey had stopped.'

It would therefore appear that the Painted Partridge does call outside the breeding season—though perhaps only late in the evening, for it is unlikely that we could have missed the call during the daytime over all these years in the Konkan.

75, Abdul Rehman Street,
Bombay 3,
February 2, 1965.

HUMAYUN ABDULALI

7. FOOD OF THE WHITEBREASTED KINGFISHER [*HALCYON SMYRNENSIS* (LINNAEUS)]

Rawal Lake, situated a few miles north of Rawalpindi, has been newly formed by the construction of a small dam, to provide for the increased water requirements of that city as well as the new capital of Islamabad. It is about 1100 feet above sea-level, and as yet is surrounded only by tall grass with no trees or even large bushes in the vicinity.

On September 6th the two of us, while motoring past, stopped to watch the birds around an arm of the lake, which extends to the roadside. Among other birds we observed, perched on overhanging brambles on the steep earth bank above the water, groups of 2 or 3 Pied Kingfishers (*Ceryle rudis*), a solitary Common Kingfisher (*Alcedo atthis*), and two Whitebreasted Kingfishers (*Halcyon smyrnensis*) all within a distance of fifty yards from each other—a concentration of kingfishers such as I have never seen before.

We had just noticed a flock of about eight Whitethroated Munias (*Lonchura malabarica*) feeding on grass seed growing on top of this earth bank, when suddenly one of the Whitebreasted Kingfishers darted from its perch and seized a munia in its powerful bill. It flew off towards the main body of the lake with the munia protesting loudly and struggling violently. The kingfisher kept on flying till, suddenly, a shower of feathers erupted from its beak and the munia, apparently minus its tail, made good its escape. By this time, the kingfisher was at a considerable distance, but through the binoculars it appeared still to have a bill-full of feathers, almost as bulky as munia itself.

KHANEWAL,
WEST PAKISTAN,
December, 1964.

T. J. ROBERTS
C. PRIDDY

[A case of a Whitebreasted Kingfisher catching and eating a smaller bird (probably a White-eye) was reported by S. N. Sen (1944, *J. Bombay nat. Hist. Soc.* **44** : 475.—EDS.]

8. NOTES ON INDIAN BIRDS 3—THE ALPINE SWIFT, *APUS MELBA* (LINNAEUS), WITH A DESCRIPTION OF ONE NEW RACE

(*With a text-figure*)

The paucity of specimens available has prevented an appraisal of the races of the Alpine Swift (*Apus melba*) in India. Stuart Baker in the FAUNA (1927) accepted the nominate race, described by Linnaeus in 1758 from Gibraltar, and mentioned the range thus: 'The mountains of Northern Africa and of Southern Europe as far north as the Alps; South-West Asia to practically the whole of India and Ceylon. It is found as far east as Assam and is common during the winter in Cachar and Sylhet.' He drew attention to the fact that birds from south

India were smaller and darker with the wing 190-195 mm., never exceeding 200 mm.

In 1928, on these differences, Hartert separated the Ceylon birds as *bakeri* and Stuart Baker referred to this in the FAUNA **8**, p. 680, indicating the differences as identical with those mentioned by him earlier and gave the range as ' mountains and hills of Ceylon and Southern India '.

In 1954, Koelz described *nubifuga* from Rathi, Kumaon, the type being a ♀ with a 205 mm. wing, and included birds from Mysore with wings 202·5 to 206 as of this race.

Ripley in the SYNOPSIS has accepted three races from India and Ceylon:

(*a*) *melba* (Linn.): Wintering in West Pakistan and north-western India;

(*b*) *nubifuga* Koelz : All India south to Kerala, east to Assam and East Pakistan; breeding in the Himalayas and in Mysore;

(*c*) *bakeri* Hartert : Ceylon.

In November 1944, I collected one out of a large flock of swifts that swooped down to drink at the Patalganga River, Kolaba District, on the mainland opposite Bombay, and its large 226 mm. wing aroused my interest and led me to examine these birds more carefully. I have subsequently been able to obtain some more specimens from the neighbouring areas and, as these together with the other material available do not tally with Ripley's account in the SYNOPSIS, I attempt a reassessment.

The range of measurements in the two sexes is almost identical and, in view of the relatively small number of specimens available for examination, I am referring to both sexes together. There appears to be no difference in the plumages in the different seasons. The material available falls into the following subspecies :

1. bakeri Hartert Only 2 specimens are available from Ceylon. These are darker than 9 skins from south India [Jog (Gersoppa) and other places in North Kanara (7), Palnis (1), and Coimbatore (1)], but can be matched in colour with the two from Yewat, Poona (Maharashtra), referred to in item **2** below. In the two Ceylon specimens the brown edges to the white of the chin appear wider at the level of the gape, making the white narrower.

Dr. Charles Vaurie to whom I sent a draft of this note informs me that, allowing for the north to south cline in size, the birds from Ceylon are darker as well as smaller. He measured the wings of 5 males from Ceylon 194-207 (199·5). These measurements agree with those of south Indian birds (see Table), which are different from *nubifuga* (type locality Kumaon, U.P.) and the birds should either be included with *bakeri* or described as a separate race. In the absence of sufficient material, I am

MEASUREMENTS OF *Apus melba* (Linnaeus)

Particulars of specimens	No. of specimens	Wing	Tail	Breast band
A. m. bakeri (*a*) from Ceylon .. (*b*) from S. India ..	2 9	199-204 av. 201·5 196-207 av. 201·2	69-70 av. 69.5 68-76 av. 73·3	28-30 av. 29 16-31 av. 25·5
Specimens from Bombay Deccan ..	6	194-207 av. 201	65-75 av. 71·5	31-42 av. 36
A. m. nubifuga from northern hills (Simla &c.) ..	7	212-217 av. 214	71-85 av. 76	17-37 av. 25
A. m. tuneti ..	7	213-222 av. 216·6	75-89 av. 79	11-29 av. 26
Specimen collected in Kolaba District in Nov. 1944 ..	1	226	81	damaged
Specimens from Saurashtra and Mount Abu ..	4	212-218 av. 215·25	70-76 av. 72·5	32-38 av. 35·5

for the moment following Stuart Baker and leaving them as *bakeri.* The Ceylon birds are said to be subject to considerable erratic local movements, and the Gersoppa birds were not seen in June and August by McCann and myself, though McCann noted them in the Palnis in June and July. A pair shot during Christmas week were in breeding condition (Abdulali 1936, *J. Bombay nat. Hist. Soc.* **38** : 829).

Meinertzhagen (Birds of East and Tropical Africa. *Ibis* 1922 : 34-35) saw large breeding colonies on the eastern escarpment of the Nilgiri Hills, but failed to obtain specimens. Daily movements of large numbers far from suitable breeding places have been recorded.

2. I have six specimens from India from the area which may be termed the Bombay Deccan [Yewat, near Poona (2), Tungar Hill, Thana, Bombay (1), Ghoti, Nasik (2), and Chikalda, Berar (1)], which are similar to birds from further south, but in which the breast band is noticeably broader.

The two birds from Yewat, a male and female shot out of several parties hawking over the plains in twos and threes, are as dark as those from Ceylon, but of course with broader breast bands.

The wider breast band separates them from birds both from the south and the north ; in the latter the breast band is narrower than the figures suggest. In series they are darker than *nubifuga* and also appreciably smaller (see Table).

Lt. H. E. Barnes (1886, *J. Bombay nat. Hist. Soc.* **3**:47) refers to ' Mr. Davidson of Malligaum (? Malegaon, *c.* 55 miles NE. of Nasik—H.A.) ' showing him both nests and nestlings of the Alpine Swift obtained by him from fissures in rocks in the mountains in ' that district '. He adds that the nests showed signs of having been attached to the rock on two sides and were of very solid structure in comparison with those of the Common Indian Swift. Later, in April 1887 Davidson took a half-feathered chick at Saptashring, near Nasik, (Whistler, *J. Bombay nat. Hist. Soc.* **28** : 30) ; the species is therefore resident in this area.

In view of these differences, I would restrict *nubifuga* to its Himalayan limits and hereby name the birds from the hills and ghats near Bombay

Apus melba dorabtatai subsp. nov.

The name is a small token of my appreciation of the generous aid so often given by the Sir Dorabji Tata Trust, Bombay, to the Bombay Natural History Society and to many individuals engaged in scientific research.

Holotype : ♂ in the Bombay Natural History Society's collection bearing Register No. 20027, collected by me at Ghoti, Nasik District, Maharashtra State, on 13 February 1955, *Paratypes* : 1 ♂ No. 19725, 4 ♀♀ Nos. 11560, 19305, 19306, 19726 in the Society's collection.

3. **nubifuga** Koelz 1954, Contrib. Inst. Regional Exploration No. 1 : 25. The original description reads :

'Type ♀ Rathi, Kumaon, June 9, 1948, Thakur Rup Chand collector, W. 205.

'Compared with the type of *A. m. bakeri* (Ceylon ; A.M.N.H.), paler above, less black in body plumage and with a broader breast band. The race *bakeri* is described as nearly as dark as *A. m. africana* ; this is confirmed by a study of specimens in American Museum of Natural History.

'Compared with a long series of *A. m. tuneti* from Tunis (A.M.N.H.) and Afghanistan, darker, with broader breast band and smaller white throat patch.

'Hardly distinguishable in colour from the nominate race *melba* (Gibraltar ; A.M.N.H.) but averages a bit darker, the breast band wider and throat patch smaller. The wing is smaller.'

The wing of the type specimen appeared to me too small for a northern bird and Mr. R. W. Storer of the Museum of Zoology, University of Michigan, kindly examined the type. He measured the right wing as 207 mm., and said that he 'could not be certain that there was any remnant of a sheath at the bases of the primaries'. The left wing measured about the same, but 'the tips of the outer two primaries are damaged. The outer primary is not larger than the next and, judging from our only other skin of the species (an example of *tuneti* from Afghanistan), the outer primaries lack 3 to 5 mm. of their full growth'. He added that the label bore the remark 'Belly patch', by Koelz, presumably meaning incubation patch, and another in pencil in van Tyne's handwriting : 'Very much like *bakeri* in colour and size'. It appears that the wing measurements of *nubifuga* in the original description are not very representative.

The measurements of 7 skins from the northern hills [Simla (4), Chanoli, Garhwal (1), Ghaggar, Ambala (1), and Chitral (1)] are indicated in the Table. The ♂ from Chanoli, Garhwal, dated 12 May 1899 had enlarged testes, while the Simla specimens include 3 immature birds obtained in August and September, which together with the incubation patch on the type specimen indicates a breeding season from about May to August. There is however considerable local movement. Jones, for instance (*J. Bombay nat. Hist. Soc.* **26** : 614), refers to seeing large scattered flocks in spring and autumn and says that it departs from Simla at the end of April and returns in October. Whistler (*J. Bombay nat. Hist. Soc.* **32** : 727) noted them on various dates from 11 April to 17 May, and said they were more numerous on autumn migration, 21 August to 24 September, often in very large numbers.

The British Museum have lent me for examination a skin obtained by Davidson at Simla on 23 August 1877, which is paler than the other specimens and has an attenuated tip to the outer tail feathers as in *tuneti* (q. v.) and may well be of that race. Even if *nubifuga* is restricted to the northern hills, the paucity of specimens and other information over this wide range is very obvious and requires a much more careful examination.

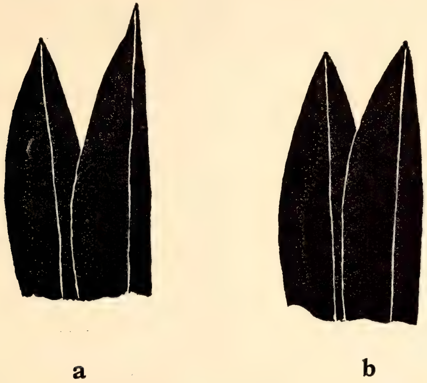
4. tuneti Tschusi Meinertzhagen (loc. cit.) wrote: 'I have recently collected a series of 10 from Palestine and Crete. They are all paler and greyer in colour than those breeding elsewhere in Europe and the Himalayas . . . . agree with breeding birds from North Africa, *tuneti* from Tunis.' He questions the identity of *melba* Linn., named 'after a figure by Edwards of a bird from Gibraltar', and says: 'The colour is particularly dark, even darker than most birds from Southern Europe, and *melba* would apply to South European birds. If *tuneti* is separable, it would apply to birds breeding in Northern Africa, Somaliland, Arabia, Crete, Palestine, east to Persia, but not to Baluchistan and the Himalayas . . . .'. Unfortunately he does not indicate what race inhabits the last area!

This race has not been recorded from India, but the bird shot out of a large flock was obviously a migrant and its size compares well with 6 specimens from northern Shiraz (1), Murghat Herat, Afghanistan (1), Palestine (3), NW. Himalayas (1), and the Simla specimen referred to above, which all appear to be *tuneti* (see Table). The specimen was sent to Dr. Mauersberger at the Zoological Museum at Berlin, and he stated that it matched their series of *tuneti*, and was distinctly paler and greyer than most *melba*. There is some variation in the colour of the upper parts, but the Bombay bird is paler than any specimen of *nubifuga*, *dorabtatai* or *bakeri*. In all the eight specimens, the outermost tail feathers appear to taper to a sharper point than in the others, and this character is illustrated in the accompanying sketch. It has been suggested that this is a character which may be dependent upon the age of the individual, but it is not visible in any of the other skins examined.

5. Four birds [Hingolgadh, Saurashtra (3), and Mt. Abu (1)] all taken in September can be picked out from all Indian specimens by the upper parts being grey rather than brown. Sálim Ali has identified them as *melba* and these are probably the specimens of the nominate race from Saurashtra and Mt. Abu in the Bombay Natural History Society collection mentioned in the SYNOPSIS.

One skin was sent to Dr. Mauersberger who found it 'paler than *melba* and about matching *tuneti*'. In series I find them quite different from those which I have identified as *tuneti*.

Sálim Ali obtained a male at Gujri in Dhar State on 4 September 1939 with a 214 mm. wing which Whistler (*J. Bombay nat. Hist. Soc.* **41**: 474) identified as *melba*, though he noted that the wing was a little small for the typical race. He said it agreed with his series from north-west India, being too pale for *bakeri*. Perhaps this was similar to the birds described here.



Outer tail feathers of:
(*a*) *Apus melba tuneti*; (*b*) *A. m. bakeri*

The fact that the four skins available from a restricted area are noticeably different from the four races referred to above prompts me to believe that they represent an undescribed race. Butler (*Stray Feathers* 3:453) said the Alpine Swift 'arrives at Mount Aboo in large numbers about the beginning of September and remains during part of the cold weather'. In the absence of any evidence regarding their breeding in the area and their subsequent movements, I am not separating them at this stage. I trust that further evidence will soon be available and permit a clarification.

I realize that this note is not exhaustive and I hope that those who have the opportunity will obtain more specimens, preferably of breeding birds, to try and clarify matters. With their wonderful powers of flight the swifts probably cover vast distances, but a fairly specialized type of nesting site is necessary. Many such sites may hold distinct populations and it is not improbable that it may be possible to associate the differences, now visible and accepted as individual variations in the same race, with different breeding populations.

I am grateful to the authorities of the Zoological Survey of India, the British Museum, the Colombo Museum, and the Tel-Aviv University for the loan of skins for examination, to Dr. Charles Vaurie of the American Museum of Natural History for his comments on a preliminary note, to Dr. R. W. Storer of the Museum of Zoology, University of Michigan, for notes on the type specimen of *A. m. nubifuga*, to Dr. Sálim Ali for access to several references, and particularly to Dr. G. Mauersberger of the Zoological Museum of the University of Berlin for his comments on the specimens sent to him.

75, Abdul Rehman Street,
Bombay 3,
October 17, 1964.

HUMAYUN ABDULALI

9. SWALLOWS *HIRUNDO RUSTICA* LINNAEUS ROOSTING ON WIRES

(*With a plate*)

I have seen swallows roosting in enormous numbers in reed beds (*Phragmites karka* Trin.) in Kerala and near Calcutta, and in sugarcane fields in Rajasthan and Kerala. Sálim Ali (1962)[1] has reported them as roosting in mangroves at Bombay. I recently noted swallows *Hirundo rustica* roosting on electric power lines near Dharavi, Bombay. Swallows collecting in large numbers on electric as well as telephone wires during the day is a common sight but, so far as I am aware, they have not been reported as roosting at night on such exposed perches. The roost was first noticed on 12 December 1963, and was in use as such till 20 January 1964, when I left Bombay for a couple of months. It was found abandoned on my return to the site on 5 April 1964. The roost was already occupied on 30 August 1964, when I visited the place again, and continues to be still in use. The roosting behaviour of these birds is under observation and will be reported later.

The photographs accompanying the note were taken on 2 November 1964 at 9.45 p.m.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6-wb..
February 2, 1965.

P. V. GEORGE,
Research Scholar

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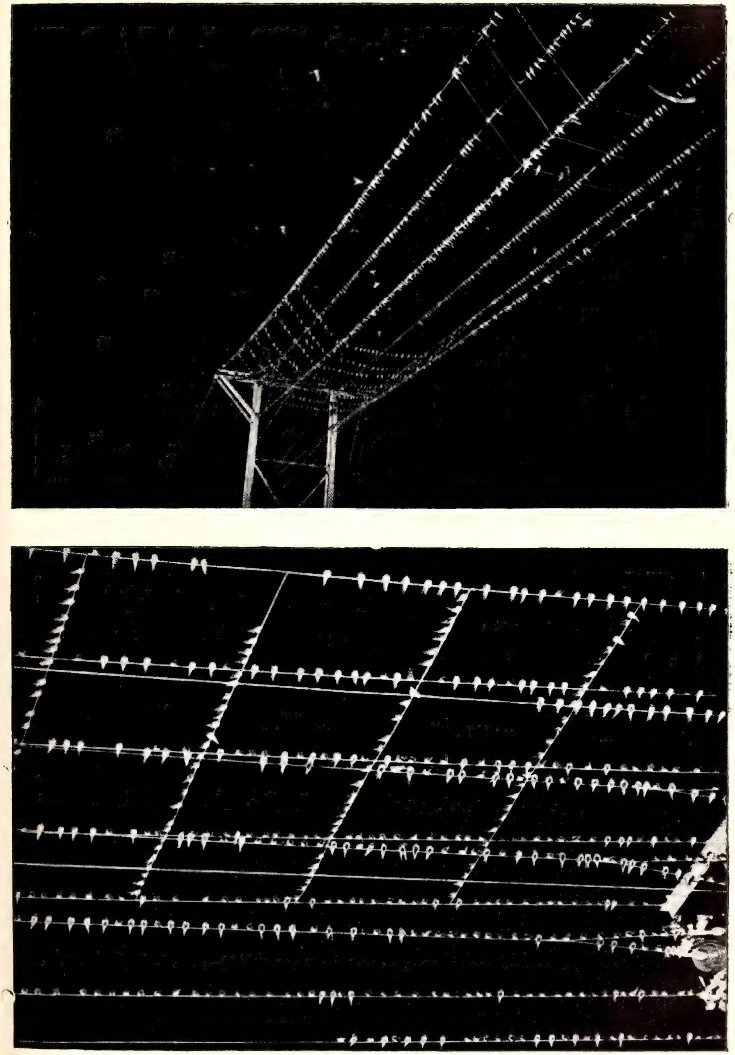
[1] Sálim Ali (1962): The BNHS/WHO Bird Migration Study Project—2. *J. Bombay nat. Hist. Soc.* **59** (3): 921-929.



Swallows (*Hirundo rustica*) roosting on electric power lines at Dharavi, Bombay

Photos: P. V. George

10. ON THE OCCURRENCE OF FINSCH'S STARLING (*STURNUS VULGARIS POLTARATSKYI* FINSCH) NEAR BOMBAY

On 29 November 1964, while shooting snipe at Rewas (across Bombay Harbour), Alibag Taluka, Kolaba District, Maharashtra, I saw a party of about a dozen starlings over marshy land. They settled on telegraph wires in front of my companion Krishna Talcherkar who, at my request, fired into them dropping four, a male and three females.

Stuart Baker in the FAUNA (**3** : 31 et seq.) accepted seven races from Indian limits, but only five of them are included in Ripley's SYNOPSIS (1961). Judged by their wing measurements [128-135 mm. (♂♂)], purplish heads and throats, and greenish upper- and underparts, the present birds are *Sturnus vulgaris poltaratskyi* Finsch (Type locality: Marka-Kul, Eastern Kazakhstan). This race is accepted as a common winter visitor to West Pakistan and northern India and, though specimens have been obtained at Madras (Whistler, *J. Bombay nat. Hist. Soc.* **36** : 587), it is said to be an uncommon straggler in Gujarat (Sálim Ali, *J. Bombay nat. Hist. Soc.* **52** : 796). There appears to be no earlier record of this species from the Bombay area.

75, ABDUL REHMAN STREET,
BOMBAY 3, HUMAYUN ABDULALI
December 8, 1964.

11. PLANTS EATEN BY *UROMASTIX MICROLEPIS* BLANFORD AND OTHER NOTES ON THIS LIZARD IN EASTERN ARABIA

It is a well-known fact that the spiny-tailed lizard (*Uromastix*) is herbivorous. The writer has seen many of these lizards during desert trips in eastern Arabia without, however, ever observing one in the act of feeding. Nor was much learned about their diet through observations of captive specimens, for of several lizards kept for weeks at a time all refused to eat anything in captivity.

Mr. Harry Alter and the writer made a trip inland from Dhahran on 7-8 May 1964; one of the purposes of the journey was to test the palatability of *Uromastix* as human food. Six specimens of *Uromastix microlepis* Blanford were taken between Niṭā (27° 13′N., 48° 25′E.) and Abwāb (26° 07′N., 48° 56′E.) on May 7-8 in the Wādī al Miyāh area, a low-lying region particularly favoured by this lizard. All of the spiny-tailed lizards reported from eastern Arabia have been of this species.

The last three taken by the writer on May 8 were collected 55 km. west of Al Lidām (' Jebel Dam '), where Gasperetti took a specimen (CAS 84430) in 1946 that was subsequently presented to the California Academy of Sciences (Haas 1957). The writer identified the following plant species from fragments in the stomach contents of the six specimens :

1. *Astragalus gyzensis* Del. (Leguminosae) : leaves and pods
2. *Citrullus colocynthis* (L.) Schrad. (Cucurbitaceae) : a few seeds
3. Gramineae : one grass spikelet, not identified (*Aristida plumosa* L. is common in the area)
4. *Horwoodia dicksoneae* Turrill (Cruciferae) : flowers and (probably) leaves
5. *Launaea capitata* (Spreng.) Dandy (Compositae) : leaves and flower buds
6. *Moltkiopsis ciliata* (Forsk.) Johnst. (syn. *Lithospermum callosum* Vahl (Boraginaceae) : leaves and flowers
7. *Neurada procumbens* L. (Rosaceae) : leaves and fruits
8. *Plantago boissieri* Hausskn. et Bornm. (syn. *P. albicans* L. : Plantaginaceae) : leaves and flowers.

Several of the lizards killed were females that contained large yellow masses of ovarian eggs. The testes in the males appeared to be enlarged and active.

It was noted that specimens seen early in the morning shortly after sunrise were quite dark in colour—a dark slate-grey. The lizards were extremely wary at this time and seldom ventured further than a few yards from their burrows, diving into their holes at the slightest disturbance. As the morning wore on and the temperature increased, all the lizards seen became lighter in colour. By midday they were nearly white to bright yellow. Similar colour changes have been reported for *Uromastix loricatus* (Blanford) in Iran (Anderson 1963), and Schmidt-Nielsen (1964) has discussed the significance of colour changes in controlling the body temperature of desert reptiles.

Most of the writer's specimens were taken at midday, when the lizards' behaviour had changed almost as remarkably as their colour. At this time they ventured far from their burrows, sometimes to a distance of several hundred yards and were, contrary to expectation, easily approached on foot. They lay motionless and moved in many cases only after being touched ; then they were off for the burrow at a speed that could be matched by a running man only with great effort. All of the specimens killed had full or nearly full stomachs. The lizards apparently feed before noon and then lie in the sun at some distance from their holes, depending on their motionless state and light colour for protection. The general boost in metabolism provided by the noonday heat may be an aid to the digestive process.

Uromastix (Arabic *ḍabb*, pl. *ḍubbān*) is a fairly common element in the diet of many Bedouin Arabs, and specimens are occasionally sold alive in the markets for food. The whole carcass is usually roasted in the skin by burying in hot coals, although most of the meat is found in the tail and hind legs. Any eggs found are put back into the abdominal cavity to roast or are enclosed in the cleaned stomach for steaming. The writer and a companion roasted the tails and hind legs of two specimens and found the flesh tasty, if somewhat fibrous and stringy. There is no 'gamey' flavour; it tastes more like somewhat tough lamb than the chicken or fish to which it has been compared. Some portions of the tails were overdone, and the burned horny scales imparted an unpleasant flavour to the underlying meat. Boiling or roasting after skinning thus might be preferred. *Uromastix* is found over wide areas in the Saharo-Sindian desert region and is fairly easy to capture. It should be considered a primary survival food source for this area.

ARABIAN AFFAIRS DIVISION,
ARABIAN AMERICAN OIL COMPANY, J. MANDAVILLE
DHAHRAN, SAUDI ARABIA,
January 10, 1965.

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12. OCCURRENCE OF THE SUNFISH *RANZANIA TRUNCATA* (RETZIUS) NEAR VERAVAL, ALONG GUJARAT COAST[1]

On 12 May 1963, an uncommon fish was caught off Jaleshwar village, about 2 miles north of Veraval, by fishermen operating a gill-net in about 30 metres depth of water. Not having seen this type of fish before, they brought it to this office for identification and it was identified as the sunfish *Ranzania truncata*.

Deraniyagala (*J. Bombay nat. Hist. Soc.* **44** : 429) and Chacko & Mathew (*J. Bombay nat. Hist. Soc.* **53** : 724) have recorded *Ranzania truncata* from Ceylon waters and Beypore (Malabar coast) respectively.

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[1] Published with the permission of the Superintending Engineer, Deep Sea Fishing Station, Bombay.

Apart from these two records, there appeared to be no records about its occurrence north of Beypore on the west coast of India[1]. Its occurrence on the Gujarat coast is therefore placed on record. Also some important measurements (in cm.) are given:

Measurements in cm.

Total length—60·2
Length to base of caudal—57·2
Depth of body—38·7.
Depth of body near pectoral—30·5
Depth of body near dorsal and anal—26·0
Length of head—23·0
Snout—8·4
Diameter of eye—3·7
Distance between eye and opercle—8·9
Length of pectoral—12·3, width of base—3·1
Length of dorsal—19·1, width of base—8·0
Anal damaged—width of base—6·4

Colour: Greyish black above and below in line with dorsal and anal, with some indistinct white bands. Eight cross bands extending from snout to base of pectoral. First two bands without blotches, subsequent bands blotched irregularly, last two indistinct. Sides of body whitish grey. Fins in general black, pectoral transparent and yellowish at the base. Round black spots with white circles in region above anus.

The occurrence of the sunfish in coastal waters is rare. Fishermen in South Africa believe that a sudden storm follows its appearance in coastal waters and hence they suspend fishing operations and return to base. It is interesting to record that, soon after the present capture, the fishermen had to suspend fishing operations owing to inclement weather. A possible reason for its occurrence in coastal waters would appear to be spawning migration, as the specimen examined, a male, was oozing milt even with a little pressure.

DEEP SEA FISHING STATION,
VERAVAL, M. J. PRADHAN
August 21, 1964.

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[1] It has been recorded from Bombay Harbour (*J. Bombay nat. Hist. Soc.* **61** : 453-456.—EDS.).

13. REMARKABLE GROWTH OF FISH IN SANDAIMEDU DEMONSTRATION TANK (NORTH ARCOT DISTRICT, MADRAS STATE), WITH A NOTE ON ITS ECOLOGY

The major Indian carps, *Catla catla, Labeo rohita,* and *Cirrhina mrigala,* are well known for their rapid growth. Chacko & Ganapati (1950) recorded a weight-increase in catla of 5½ lb. (2·5 kg.) in 5 months in a pond at Kancheepuram. This fish is reported to have grown 7-9 lb. (3·2-4·0 kg.) in a year in polluted water (Chacko 1948, Chacko & Kurian 1948). Mrigal grew 3-4 lb. (1·4-1·8 kg.) in a year in certain ponds in Madras (Chacko & Ganapati 1951). In this context it is interesting to record the remarkable growth of rohu in Sandaimedu Tank in Chengam Town in North Arcot District, an isolated, square-shaped, perenial tank, with a mean depth of 1·5 m., a maximum depth of 4 m., and an area of 0·4 acre (0·16 hectare). The tank is used for washing clothes and bathing cattle, and slight pollution occurs by domestic drainage from half a dozen huts.

Early in 1960 the Madras Fisheries Department took over the tank for the demonstration of fish culture and stocked it with catla, rohu, mrigal, tilapia, chanos, and mirror carp. On 3 February 1960, 7 rohu and 7 mrigal of sizes 12-15 cm. (weighing 50 gr. or less) were introduced and fourteen months later, on 5 April 1961, a rohu weighing 11·25 lb. (5·2 kg.) was taken from the tank. Other species have shown good growth in this tank, though not as rapid as rohu. Mrigal grew to 5·5 lb. (2·5 kg.) in two years. Milk fish (*Chanos chanos*) grew to 1 lb. (0·45 kg.) in one year and 1·6 lb. (0·73 kg.) in 1½ years, and two of them reached 3·3 lb. (1·5 kg.) in 21 months. This growth is comparable to that recorded by Chidambaram & Unni (1946). The average weight of chanos caught from this tank is 400-500 gr. Mirror carp (*Cyprinus carpio*) grew to 1 lb. (0·45 kg.) in 8 months, 1·5 lb. (0·73 kg.) in 9 months, and 1·75 to 2·0 lb. (0·65 to 0·9 kg.) in 1 year, which is better than the growth recorded by Alikunhi & Ranganathan (1946) for this fish. Catla grew to 6·6 lb. (3·0 kg.) in 15 months, but only a few had reached 4·4 lb. (2·0 kg.) at the expiry of 7 months. Fish production in this tank works out at 1300 lb. (590 kg.) per acre in 1961 and 1076 lb. (490 kg.) in 1962-63, a fairly good yield for unfertilized water.

The ecological features of this productive tank are given below:

Chemical quality

Free carbon dioxide 0·0-1·76 p.p.m., Carbonate 0·0-26·8 p.p.m., Bicarbonate 81·6-183·0 p.p.m., Chloride 60·0 p.p.m., pH 7·7-9·2, dissolved Oxygen 2·1-11·0 mg/l, hardness 87-96·0 p.p.m. (as $CaCO_3$). Phosphate 0·0-0·08 p.p.m., Silicate 9·5 p.p.m., Calcium 24·0 p.p.m. and electrolytic conductivity 420-470 μ mho.

Plankton

The secchi disc visibility was low, 15-20 cm. only, owing to plankton blooms. The net plankton 30-40 μl/L, but the plankton volume was greater when it was allowed to settle with Lugol's iodine—600 μl/L. The dominant genera were, *Microcystis, Oscillatoria, Euglena, Trachelomonas, Ulothrix, Staurastrum, Coelastrum, Chlorococcum, Scenedesmus, Nodularia, Melosira, Navicula, Cyclotella, Merismopedia,* and *Oocystis* among phyto-plankton, and *Daphnia, Cyclops, Brachionus, Eubranchipus, Nauplius* larvae, and Anureae among zoo-plankton. The zoo-plankton was as abundant as in cowdung-manured nursery ponds. Abundant bottom fauna of gastropods, molluscs, and chironomid larvae were also present. *Marsilea quadrifoliata* was noted on the surface of the water. The soil had a pH of 7.8 with an available Phosphorus content of 1·05 p.p.m., Calcium content of 40·0 p.p.m., and Ammonia content of 2·0 p.p.m. The high alkalinity due to Bicarbonates, the alkaline pH, the medium hardness, presence of nutrients such as Phosphate and Silicate, Calcium, etc., and the high dissolved salts (as indicated by the electrolytic conductivity) indicate the favourable conditions of the water. This is reflected in the good plankton production which in turn has led to good growth of fishes.

FRESH WATER BIOLOGICAL STATION,
BHAVANISAGAR,
July 7, 1964.

A. SREENIVASAN,
Assistant Director

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14. ON *EOCYZICUS* SP. (CONCHOSTRACA, BRANCHIOPODA) AT PANCHGANI, W. INDIA

(*With one text-figure*)

Branchiopods in India as in South Africa (Barnard 1929) are found at high altitudes, on the Himalayan range in the north and the Sahyadri range along the west. The Tableland at Panchgani (N. Satara altitude 4296 ft.) is one such place. It is unique in that within a radius of a few hundred yards, four phyllopods belonging to four different orders of the sub-class Branchiopoda are found in abundance. The forms recorded in the past are *Triops orientalis* (Tiwari), 1951 (Notostraca), *Streptocephalus dichotomus* Baird (Anostraca), *Leptestheriella gigas* Karande & Inamdar, 1959 (Conchostraca), and *Daphnia* sp. (Cladocera).

In August 1956 while making routine collections of branchiopods at Panchgani, twenty-five individuals of *Eocyzicus* sp., commonly known as *Estheria*, were found, adding one form to the list of phyllopods earlier recorded from this place. Since 1849 seven different species of *Eocyzicus* have been reported from the Indian sub-continent, three of them from Pakistan and four from India (personal communication from Dr. K. K. Tiwari, Zoological Survey of India).

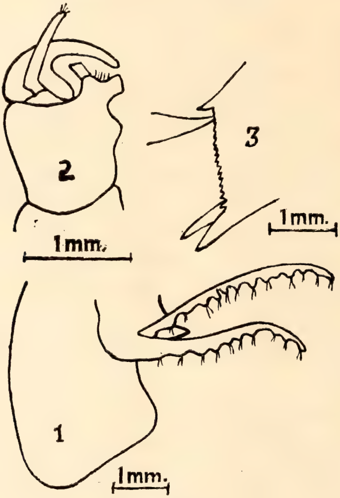
These *Eocyzicus* forms could be collected only that once at Panchgani and nearly twenty attempts made since 1956 to collect more have failed. The need to collect these Estheriids is particularly compelling now as the specimens collected in 1956 have been misplaced. The total disappearance of these *Eocyzicus* forms amidst the abundance of other branchiopods is very common in many phyllopod Crustaceans (Fox 1949). The eggs of branchiopods need desiccation prior to hatching (Barnard 1929; Karande & Inamdar 1961) and this kind of prolonged but temporary absence may be caused by two independent factors: (1) inadequate desiccation of the fertilized eggs, and (2) insufficiency of water for wetting and the subsequent hatching process.

The following are the taxonomic characters of the *Eocyzicus* sp. found on the Tableland, Panchgani.

The shell is rounded-ovate with 30-35 growth-lines.

The anterior angle of the rostrum of the male is slightly more than a right angle and the hind angle is rounded quadrate (Fig., 1). The profile between the occipital angle and the eye is straight. The first antenna bears 14-17 hairy papillae (Fig., 1). The second antenna has 13-15 segments on each ramus.

Out of twenty-five specimens examined, carefully bearing in mind Linder's advice, twenty-three showed 19 pairs of limbs, and only one male and one female 20 pairs. In the female the 9th and 10th limbs are ovigerous and in the male the first two limbs are prehensile. The anterior margin of the 'hand' is deeply notched (Fig., 2).



Eocyzicus sp.

1. The rostrum of male with first antenna; 2. 'Hand' of the first prehensile limb of male; 3. The telson of male

(Semi-diagrammatic)

The dorsal margin of the telson has 19-23 spines in the male, whereas in the female there are 20-29 spines. The spines in both are smooth and sub-equal except the first which is larger and stronger than those that follow (Fig., 3). The enlargement of the foremost spine on the upper margin of the telson is a useful 'firsthand' in the identification of the family Cyzicidae. The paired plumose sensory hairs on the telson are present. The dorsal surface of the body segments shows a maximum number of 13 spines. Dimensions: up to 5 to 7 mm. in the male and 5 to 6 mm. in the female. Some of the female specimens had fertilized eggs under their bivalve shells and were evidently well-grown adults. Colour: pale brown in formalin-glycerine preserved specimens.

The large number of spines on the telson and the low number of legs distinguish this form from its allied species and, therefore, are features that need further examination. The latter feature particularly may improve the description of the family Cyzicidae.

A favourably placed naturalist who can undertake frequent trips to Panchgani during the monsoon months may be able to re-discover this rare bivalve Crustacean and throw further light on its taxonomic position. To help in the search the present communication gives a detailed description of the important taxonomic characters.

We thank the Bombay Natural History Society, Bombay, for financial assistance towards the expenses of our collection trips.

DEPARTMENT OF ZOOLOGY,
THE INSTITUTE OF SCIENCE,
BOMBAY 1-BR,
September 29, 1964.

ASHOK A. KARANDE
N. B. INAMDAR

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15. VARIANT BEHAVIOUR OF *CHALYBION BENGALENSE* DAHLB. (HYMENOPTERA, SPHECIDAE)

Chalybion bengalense Dahlb. [*Sceliphron violaceum* (Fabr.)] (FAUNA OF BRITISH INDIA, HYMENOPTERA **1** : 240) is a common domestic wasp around this part of India. Jayakar & Mangipudi (1964) and the present authors have recently made some contributions to the biology of this species. The females look for convenient natural cavities including derelict nests of other wasps (Jayakar & Spurway 1964b). These they fill with spiders on one of which they have laid an egg. These cells are then sealed with elaborate lids (Jayakar & Spurway 1964a). The North American species of *Chalybion*, which were previously believed (Peckham & Peckham 1905; Rau & Rau 1918) to build their own cells, are now considered as semi-parasites on *Sceliphron* spp., either using disused cells of these species or emptying out the contents of a cell, recently sealed by the latter, before re-stocking it themselves (Muesebeck *et al.* 1951; Evans 1963). However, we have never seen an individual of *C. bengalense* opening a cell occupied by another species.

C. bengalense does not ordinarily seal her cell until she has finished its provisioning. *Sceliphron madraspatanum*, another of our common Sphecids, and the North American *S. caementarium*, on the other hand, put a temporary lid on a cell if they leave it overnight partly provisioned. This lid differs visibly from the 'permanent' lid put on the cell after it has been completely provisioned (Spurway *et al.* 1964; Shafer 1949).

It is, therefore, interesting to record that we have seen at least three individuals of *C. bengalense* putting lids on cells which were partly provisioned. These lids were removed the next morning and provisioning continued. The wasps here described nested in holes in blocks of wood in our house in Bhubaneswar (Unit 5, Type 8, No. 2). Some of these blocks are disused attachments for bathroom fittings and some are designed nest-boxes for wasps (see Jayakar & Spurway 1964b). As we have seen two individuals working simultaneously on the same block we cannot be sure that cells sealed soon after each other contain sibs. However as it is usual for several, or all, the holes in a block to be filled very rapidly, and then for that block to be neglected, sometimes for several months, we consider that these groups usually, but not critically, represent the work of a single female, each of which is referred to by the letters *C. b.* followed by an Arabic numeral. On this criterion we have now records for about 24 individuals of this species since September 1962.

On the morning of 5/9/1963 a hole in a bathroom block was found sealed (*C. b.* 7). The next day, at 08·36, this lid was found to have been removed. There were 2 or 3 spiders in the cell. More spiders were put in during that day but the cell was not sealed again.

On 18/3/64 *C. b.* 18 made a lid on 1. V which she removed in the morning of 19/3, later sealing the cell permanently.

A cell (numbered 1. VIII) in a nest-box was sealed on 14/4/1964 (*C. b.* 21). The lid was noted as being white (see Jayakar & Spurway 1964a) and 'concave' (see Spurway *et al.* 1964). The next morning, at 09·33. the lid had been removed. Later in the day, the cell was permanently sealed after further provisioning. 16/4 was a wet day. On the afternoon of 17/4 another cell in the same box was sealed, the lid being concave and pink (i.e. a thin layer of white on reddish mud). On 18/4, the cell was reopened and re-sealed with a white lid. On 19/4, the same cell was again reopened and re-sealed, the lid being white. Another cell 1. IV was sealed on 20/4, reopened and re-sealed on 21/4, and again on 22/4. No wasp worked on this block till 2/5 when lids were removed by us, and the cocoons extracted.

On 23/4, a hole in the bathroom block mentioned earlier was sealed (*C. b.* 22). It was reopened and re-sealed on 24/4. Another cell was sealed on 25/4, reopened and re-sealed on 26/4. These dates suggest that these cells may be the work of the individual whose activities were described in the last paragraph, i.e. that *C. b.* 22 and *C. b.* 21 were one and the same wasp.

On 13/5, 1. VIII was again sealed. This nest-box was continually worked on till 24/5, when 1. III was deserted with one spider in it. During this period, the wasp (*C. b.* 23) left a cell incompletely provisioned overnight on 7 occasions on 4 of which she put on a temporary lid but not on the other three. The two methods of leaving an incompletely provisioned cell overnight were intermixed. Two cells were each left unfinished for two consecutive nights. On 3 of these 4 nights, temporary lids were put on, but not on the fourth. It is possible, but improbable, that *C. b.* 23 and *C. b.* 22 were the same individual.

It is necessary to summarise the evidence that the individual who removed a lid was also the individual who constructed it. Firstly, as in *S. madraspatanum*, the lid was removed at the beginning of a day's work. No other work was done between the construction and removal of a temporary lid, and no other cell was worked on until this cell had been again sealed permanently. The ravishing of a completed cell by another individual would not be expected to occur so regularly immediately after closure, and it is even more improbable that the same cell should be the victim on two consecutive days. No spiders or debris were found removed from a reopened cell as we find when wasps prepare a previously used cell for re-use. The temporary lids can sometimes be distinguished from permanent lids by the much thinner layer of white put over the reddish mud. It is curious that any white should be used at all. These temporary lids require more loads than the 1 or 2 out of which individuals of *S. madraspatanum* construct analogous structures. Finally, of the maximum of 5 wasps who have been noted as constructing such lids, 3 constructed more than one of them.

We have, therefore, intraspecific variation in the behaviour of this species, and it is probable that the behaviour of a single individual may also vary in time. As these are the only examples of such behaviour we have seen in this species it is probably rare.

The advantages of such a behaviour pattern are obvious. Parasites of many kinds are common, for example Chrysid wasps who lay their own eggs in the cell, and so are labour parasites such as ants and Salticid spiders who remove spiders stocked in the cells. It is surprising that such behaviour has not been evolved in wasps other than *Sceliphron.*

GENETICS AND BIOMETRY LABORATORY,
GOVERNMENT OF ORISSA,
BHUBANESWAR-3,
ORISSA, INDIA,
June 2, 1964.

S. D. JAYAKAR
H. SPURWAY

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16. *IXODES KERRI* RAO, 1954 : A SYNONYM OF *IXODES PETAURISTAE* WARBURTON, 1933 (ACARINA : IXODIDAE)

(*With one text-figure*)

In 1955 the author had the privilege of describing the first member of the genus *Ixodes* ever collected in India south of the Himalayas. It was described as *Ixodes kerri,* in the belief that it was a new species after consultation with taxonomists specializing in ticks. However, later when more specimens of the tick were available in the Sagar-Sorab area of Mysore State it was realized that it could be synonymous with *Ixodes petauristae* which had been described on the basis of a single female from Ceylon by Warburton (1933). Warburton's specimen was also taken from a flying squirrel.

During the author's visit to London in 1962, the opportunity was taken to examine the type specimen of *Ixodes petauristae* in the British Museum (Natural History). It was found that the type specimen tallied in most of the essential characteristics with *Ixodes kerri* and therefore for taxonomical purposes *Ixodes kerri* has to be designated as a synonym of *Ixodes petauristae.*

During the examination of the type specimen it was found that the illustration by Warburton of the type specimen though accurate in regard to the body was not quite accurate so far as the basis capitulum was concerned. From a study of a peculiar posture of the palpi it was noticed that Warburton's illustration had in fact been made from the type specimen deposited. The inaccuracy in Warburton's illustration chiefly related to the shape of the postero-lateral border of the basis capitulum.

In the illustration by the author of *Ixodes kerri,* also, the concavity of the postero-lateral border of the basis capitulum has been exaggerated. From a study of the material at the Virus Research Centre it is seen that there is considerable variation in the shape of the basis capitulum. It would be inadvisable at this stage to use it for taxonomical purposes. However, in order to give a clear description and to set right the inaccuracy, the basis capitulum of *Ixodes petauristae* (type specimen in the British Museum) is re-illustrated here.

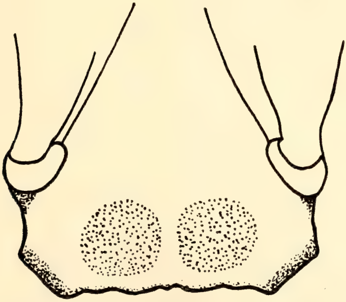

Fig. 1. Dorsal view of the basis capitulum of the type specimen of *Ixodes petauristae* Warburton, 1933

Two species of *Ixodes* are now known in south India: *Ixodes petauristae* and *I. ceylonensis.* They are so far known to be mainly concentrated in the heavy rainfall areas of the Western Ghats of Mysore State. There are also a few specimens of *Ixodes* sp. from

Vellore (Madras State) and Bhimashankar (Maharashtra State). These are all new distributional records. Studies on their distribution, bionomics, and potentialities for disease transmission are being separately dealt with.

VIRUS RESEARCH CENTRE[1],
POONA,
January 11, 1965.

T. RAMACHANDRA RAO

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17. DESCRIPTION OF THE NYMPH AND LARVA OF *IXODES PETAURISTAE* WARBURTON, 1933

(*With four figures in one plate*)

Ixodes petauristae was first described by Warburton (1933) on the basis of a single female collected from a flying squirrel, '*Petaurista philippensis* Link', in Ceylon. Rao (1955) described both the male and the female of *Ixodes kerri* collected from *Petaurista petaurista philippensis* Elliot in south India. This was the first *Ixodes* found in India south of the Himalayas but subsequently large numbers of two species of *Ixodes* have been collected in the forests of Mysore State—*Ixodes kerri,* now regarded as a synonym of *I. petauristae,* and *Ixodes ceylonensis* Kohls.

Adults of *I. petauristae* are common ectoparasites of the Giant Squirrel (*Ratufa indica*) and the Flying Squirrel (*Petaurista petaurista philippensis*) in Mysore State, south India, and immature stages have been commonly found parasitizing small mammals of the forest: shrews, rats, mice, and squirrels. They are occasionally found on monkeys but rarely on birds. The present study is based on material

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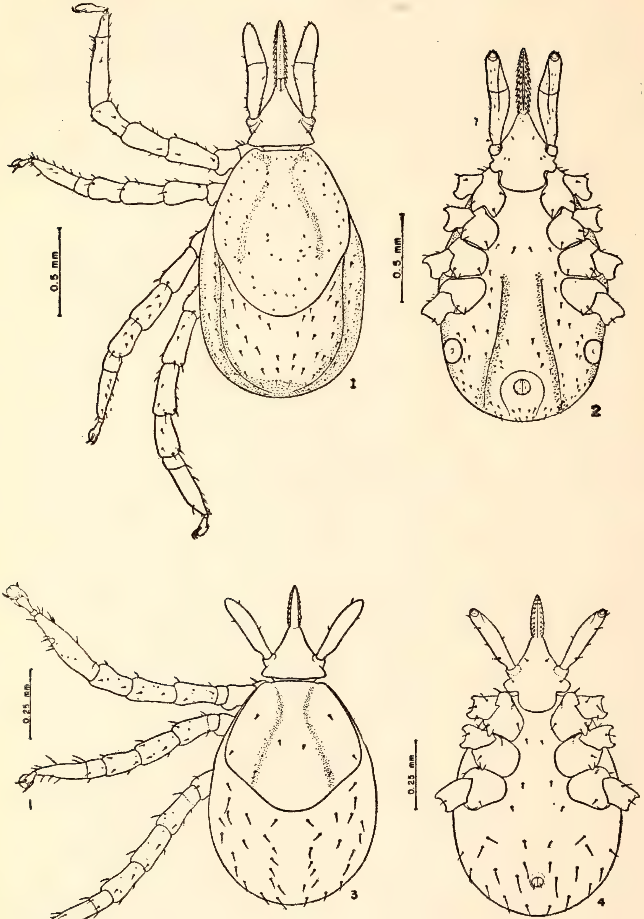
[1] The Virus Research Centre is jointly maintained by the Indian Council of Medical Research and The Rockefeller Foundation. The Centre also receives a generous grant from the PL 480 Funds from the National Institutes of Health, U.S.A.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Ixodes petauristae Warburton

1. Nymph : dorsal view ; 2. Nymph : ventral view ; 3. Larva : dorsal view ;
4. Larva : ventral view

reared in the field laboratory at Sagar, Mysore State, south India (Rajagopalan 1963). As the nymph and the larva of this species were unknown they are described and illustrated here.

I. petauristae Warburton

NYMPH (Figs. 1-2)

Body: length, excluding capitulum, 1·40[1], width 0·73; oval in shape, posterior margin rounded; marginal fold prominent, anal groove horseshoe-shaped. *Capitulum:* length, from tips of palpi to posterior margin of dorsal basis, 0·64; width at level of cornua, 0·39. Basis capituli, dorsally triangular in outline; posterior corners of dorsal basis highly sclerotised to give a cornua-like appearance; posterior margin almost straight dorsally; surface of dorsal basis with fine punctations. Ventrally, the basis is constricted posterior to the auriculae; posterior margin broadly rounded at corners; auriculae distinct as flattened lateral extensions. *Palpi:* length of second and third segments 0·56, second segment distinctly longer than the third. *Hypostome:* length 0·27, width at mid length, 0·08; dentition 2/2, about 12 teeth per file; lateral denticles larger. *Scutum:* length 0·91, greatest width 0·72; shape as illustrated, rounded posteriorly, with postero-lateral margins very slightly concave; scapula slight and short, lateral carinae distinct; cervical grooves shallow, divergent posteriorly and extending up to a little beyond the mid length. Punctations fine, with a few larger ones scattered in the posterior region. A few short fine hairs present. *Legs:* moderate in size and length. Coxa I to IV each with a distinct, posteriorly directed triangular external spur. The postero-internal margin of Coxa I angular in outline and spur-like in appearance. Tarsus I, length 0·56 tapering gradually; tarsus IV more slender than tarsus I, length 0·43 and tapering gradually (Fig. 1). *Spiracular plate* (Fig. 2): shape as illustrated; greatest length 0·18 and greatest width 0·21.

LARVA (Figs. 3-4)

Length from tip of palpi to posterior body margin, 0·98; body oval, length 0·78, width 0·59 and widest near mid length. Posterior margin broadly rounded; anal groove very faint and does not encircle the anus in front. *Capitulum:* dorsal basis, width 0·21; posterior margin of dorsal basis nearly straight, basis constricted posterior to the auriculae. *Palpi:* slender; 0·56 long and 0·05 wide; palpal articles 2 and 3 not distinctly separated. *Hypostome:* length 0·14; width 0·05; dentition 2/2 with about nine teeth in outer file and 8 teeth in inner file. *Scutum:* shape as illustrated, slightly wider than long; length 0·42 and width 0·44. Cervical grooves appear to be divergent both anteriorly and posteriorly. Lateral carinae absent. *Legs:* Coxa I with a prominent, triangular, posteriorly-directed external spur. Coxa II with a smaller postero-external spur. No distinct spur on Coxa III but the postero-external margin of Coxa III is sclerotized to form a ridge-like projection. Tarsus I tapers gradually, length 0·25, width at base 0·09. Tarsus III as illustrated.

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[1] All measurements are in millimetres and are averages of three specimens.

VIRUS RESEARCH CENTRE[1],
POONA,
January 11, 1965.

P. K. RAJAGOPALAN

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18. FRUITING OF *PLUMERIA*

With reference to Mr. Vaid's note under this heading (1964, *J. Bombay nat. Hist. Soc.* **61** : 215) both the *Plumeria* species, *acutifolia* and *rubra*, and a third species whose name I do not know, with white flowers and darker green leaves with a rounded, not pointed, apex, fruit freely in Mombasa, and obviously hybridise judging from the numerous intermediate trees that exist.

Climatic conditions in Mombasa would be more akin to those in Bombay than to those of northern India.

P.O. BOX 5026,
MOMBASA, EAST AFRICA,
November 7, 1964.

D. G. SEVASTOPULO

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[1] The Virus Research Centre is jointly maintained by the Indian Council of Medical Research and The Rockefeller Foundation. The Centre also receives a generous grant from the PL 480 Funds from the National Institutes of Health, U.S.A.

19. *MICROCOCCA MERCURIALIS* (LINN.) BENTH. : AN ADDITION TO THE FLORA OF THE UPPER GANGETIC PLAIN

During our extensive survey of the vegetation of Agra District, *Micrococca mercurialis* (Linn.) Benth. in Hook. Niger Flora 503, 1849 (Syn. *Claoxylon mercurialis* Thwaites, Enum. 271; F.B.I. **5** : 412, 1887), a small herb belonging to the family Euphorbiaceae, has been found to occur at some places like Kailash Forest, Keetham Forest, etc. It is interesting to note that the species is usually restricted to the ravines of Agra District. It is common in semi-shaded and moist places of the ravines and its associates are *Dichanthium annulatum* (Forsk.) Stapf *Fimbristylis dichotoma* (Linn.) Vahl, *Eclipta alba* (Linn.) Hassk., etc. The plant is a typically rainy season annual, as the seedlings appear after the first few showers of late July and flourish up to October, after which with the fall in humidity they wither and die off.

Older literature cites this species from south India; recently it has been reported from Khetri (Rajasthan); but there is no previous record of its occurrence from the Upper Gangetic Plain.

Its spread from the comparatively humid regions of the South to dry regions of Rajasthan and the Upper Gangetic Plain is of interest and needs further cytological and ecological investigation. Our findings regarding the number of anthers and other details of the plant species are in conformity with those of Nair & Thomas (1962) in *Curr. Sci.* **31** : 26.

DEPARTMENT OF BOTANY,
AGRA COLLEGE,
AGRA,
October 6, 1964.

K. M. M. DAKSHINI[1]
R. K. S. CHAUHAN

20. *POGONATUM SUBPERICHAETIALE* CARD. ET VARD.: A NEW RECORD FROM THE HIMALAYAS

(*With a plate*)

While working on a moss collection of Garhwal-Himalayas, the authors came across a very interesting and rare species of the genus *Pogonatum* of family Polytrichaceae, which has been identified as *Pogonatum subperichaetiale* Card. et Vard. Brotherus (1925) listed

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[1] Present address : Department of Botany, University of Delhi, Delhi 6

25 species of this genus from India and gave the distribution of *P. subperichaetiale* from south India only.

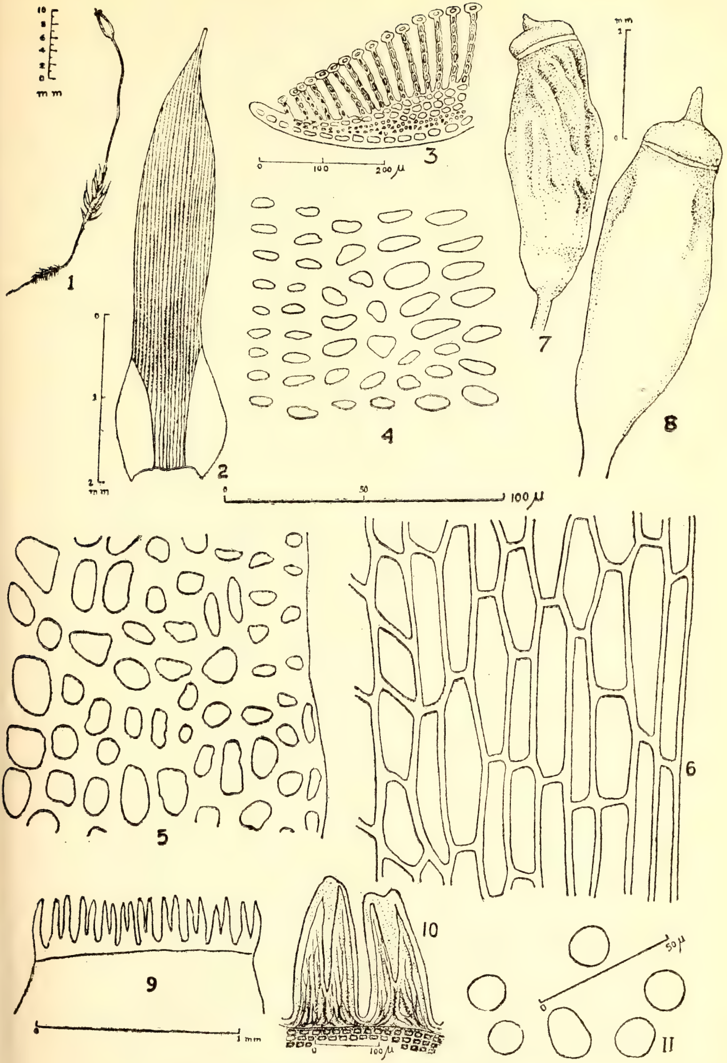
The present specimen was collected at Hamkund (Garhwal) from an altitude of 3500 m. on 31 October 1962 by Dr. U. C. Bhattacharya of Northern Circle, Botanical Survey of India, Dehra Dun, who as a Botanist accompanied the Nilgiris Expedition (Garhwal-Himalayas)—1962, and it is registered as No. *Bhattacharya* 4. This is the first record of the taxon from the Himalayas. The only reference of this species, so far, is of the type specimen collected on moist ground from Pambar Ravine, Kodaikanal, from an altitude of 2400 m. by Rev. Fr. G. Foreau on 15 December 1912. There has not been any other report of this taxon from any part of India or from any other place. Foreau (1961) in 'Moss Flora of Palni Hills' mentions only the type specimen against this species, and has not referred to any subsequent collection even from that area.

Species of this genus are often put with *Polytrichum* Dill. by some authors, but are readily distinguished by their cylindric capsules. The species in question comes close to *Pogonatum perichaetiale* (Mont.) Jaeg., because of its smooth margin, but differs from it by its acuminate apex and the upturned margin of the leaf, and also in its long sheathing perichaetial bracts.

In the present paper a detailed description of this taxon with illustrations based on the new collection is given.

Pogonatum subperichaetiale Card. et Vard. in Rev. Bryol. **50** : 25, t. 1, fig. 15a-b, 1923.

Plants in loose tufts, brownish-green. Stem 1·5 to 2·0 cm. tall, simple, sometimes forked. Leaves scale-like in lower half, higher up large (about 5 mm. long), when dry erect and clasping the stem, when moist erecto-patent, from an ovate sheathing base lingulate, at apex projected into a short acumen, margin plane slightly upturned; nerve smooth at back, stepping out into a mucro, very broad on the face of the leaf and covered with 30-40 lamellae occupying almost the entire limb; each lamella consisting of 7-9 cells, the uppermost large, roundish to elliptic, thick-walled, brownish, not papillose; areolations at the base of the limb transversely elliptical, very incrassate, 14 μ wide, becoming roundish-quadrate or sub-rectangular below, at the base rectangular, thin-walled, 18 μ wide, 3-5 times longer than broad, hyaline near the margin, pale-yellowish near the nerve. Perichaetial bracts with long sheaths, longly acuminate. Seta reddish brown, 2 cm. tall. Capsule erect or slightly inclined, oblong-cylindrical, constricted below the mouth, pale green, finely papillose, rugose when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Pogonatum subperichaetiale Card. et Vard.

1. Plant; 2. leaf; 3. T. S. of leaf; 4. cells from the shoulder region; 5. cells from the middle of sheathing portion; 6. basal cells; 7. capsule when dry; 8. capsule when moist; 9. L. S. of capsule from the peristome region; 10. peristome teeth; 11. spores

dry. Operculum large with a long beak. Peristome teeth 16, which later on, due to splitting, become 32, orange-brown. Spores circular, 16 μ wide.

The material has been deposited in the Cryptogomic Herbarium of the Headquarters Organization of the Botanical Survey of India, Calcutta, and a part in the Herbarium of Northern Circle, Botanical Survey of India, Dehra Dun, bearing Field No. *Bhattacharya* 4.

ACKNOWLEDGEMENTS

The authors express their thanks to Dr. U. C. Bhattacharya, Botanist, Northern Circle, Botanical Survey of India, Dehra Dun, for putting his valuable collection at their disposal.

BOTANICAL SURVEY OF INDIA,
CALCUTTA,
October 12, 1964.

B. M. WADHWA[1]
J. N. VOHRA

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21. *MELHANIA HAMILTONIANA* WALL.: A NEW RECORD FOR BOMBAY STATE[2]

(*With one plate*)

In the present note, *Melhania hamiltoniana* Wall., a common plant of the plains of north India, is put on record for the first time from Bombay State.

Melhania hamiltoniana Wall. Pl. Asiat. Rar. 1 : t. 77; Hooker in Fl. Brit. Ind. 1 : 372, 1874.

An erect undershrub, about 1 m. high with spreading branches. Leaves ovate sub-cordate, unequally toothed, pubescent, dark green above, white beneath. Peduncles axillary and terminal, usually three-flowered. Bracteoles recurved at the edges. Sepals lanceolate, cuspidate, villous. Petals orange-yellow, obovate, longer than the sepals. Staminodes ligulate, alternating with perfect stamens. Capsule villous, shorter than the calyx, five-celled, cells many-seeded; seeds oblong, obscurely four-sided, truncate and tubercled.

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[1] Present Address: Botanical Survey of India, Central Circle, 10 Chatham Lines, Allahabad

[2] The term is used in its former significance to include the present States of Gujarat and Maharashtra.

The plant was found on rocky hills in the vicinity of Idar.

Flowering time: August-November.

Fruiting time: October-December.

Herbarium specimens: Nos. SB 782, 783, 784, 785, collected near Idar, on rocky hills (19 October 1961).

Critical Notes. Hooker mentions the plant as occurring in Western Peninsula and Burma. The plant is fairly common in north India, from where possibly it has been introduced into the Idar region. Four species of *Melhania* have been recorded by Cooke from the Bombay Presidency; *Melhania tomentosa* Stocks is the only species reported by Cooke from Deesa, Gujarat. It would be interesting to study the range of distribution of *Melhania hamiltoniana* Wall.

The authors are grateful to Dr. G. Taylor, Director, Royal Botanic Gardens, Kew, for identifying the plant.

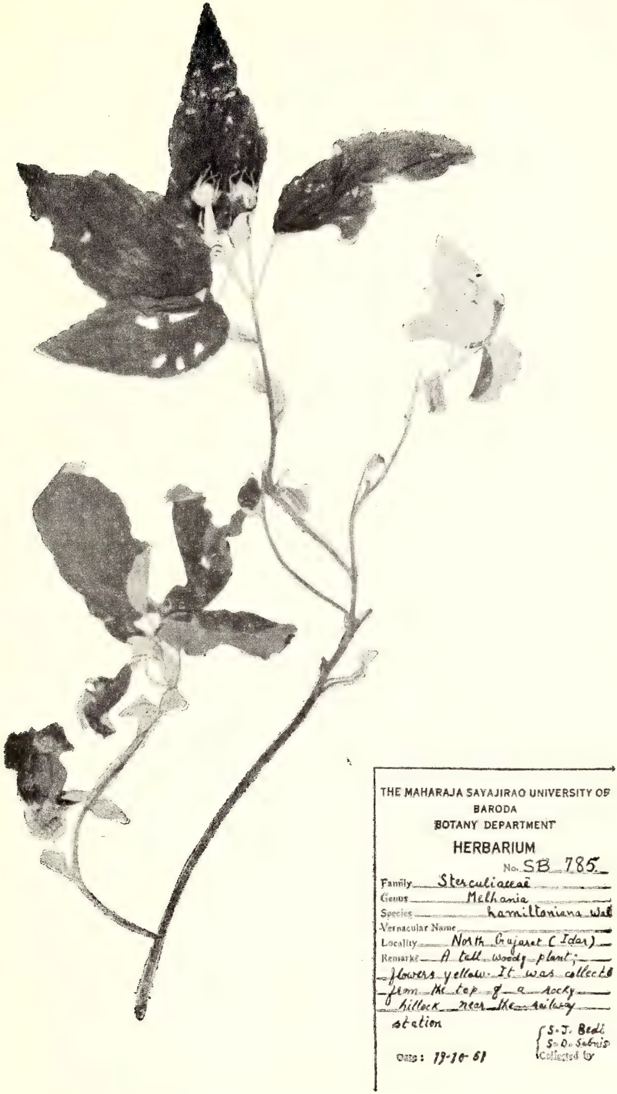
DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
August 10, 1964.

A. R. CHAVAN
S. D. SABNIS
S. J. BEDI

22. NEW RECORD OF *UTRICULARIA MINUTISSIMA* VAHL IN SOUTH INDIA

(*With one plate*)

The plant forming the subject of this note was found growing in association with *Utricularia coerulea* Linn. and *Utricularia uliginosa* Vahl in water-logged soil at Palghat, Kerala State, south India, in October 1963. On detailed examination it was found to be an unfamiliar species of *Utricularia.* Hence dried specimens together with detailed drawings were sent to Kew for identification. They identified the specimen as *Utricularia minutissima* Vahl. Hooker (in Fl. Br. Ind. **4** : 334) mentions this as an imperfectly known species. In view of the fact that this ill-defined species, as far as is known to me, has not so far been recorded from south India, I give a comprehensive description of it based on fresh specimens.



THE MAHARAJA SAYAJIRAO UNIVERSITY OF
BARODA
BOTANY DEPARTMENT
HERBARIUM

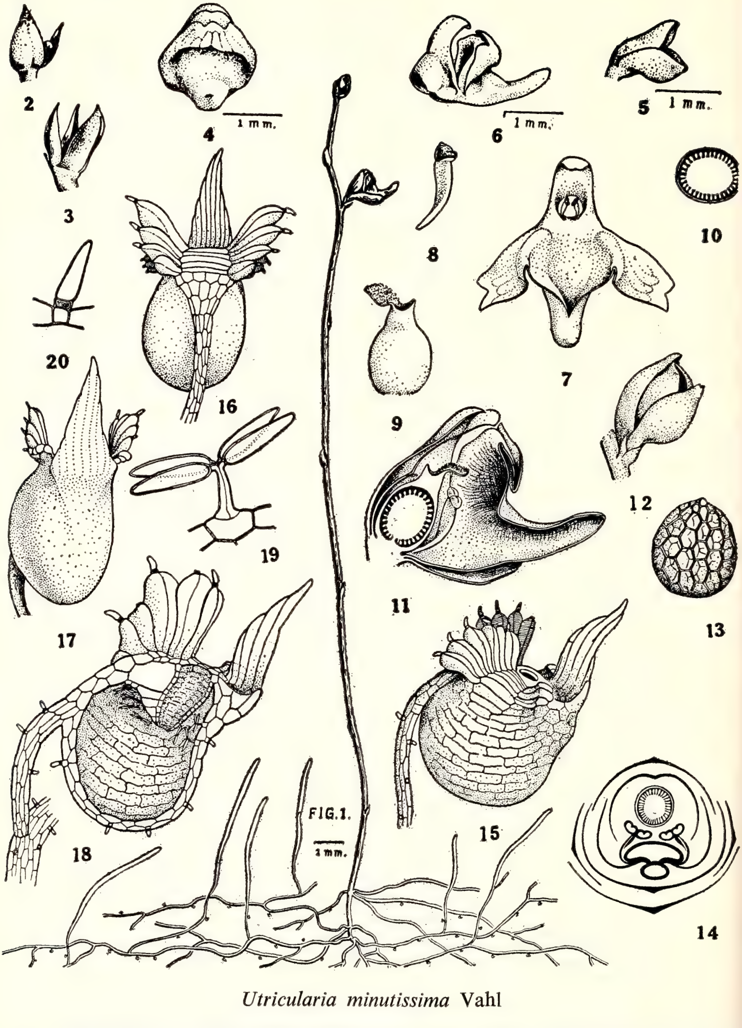
No. SB 785

Family Sterculiaceae
Genus Melhania
Species hamiltoniana Wall
Vernacular Name
Locality North Gujarat (Idar)
Remarks A tall woody plant; flowers yellow. It was collected from the top of a rocky hillock near the railway station

Date: 19-10-61

S. J. Bedi
S. D. Sabnis
Collected by

Melhania hamiltoniana Wall.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1 mm.
14

FIG. 1.

Utricularia minutissima Vahl

1. Entire plant; 2. Sterile bract and bracteole; 3. Fertile bract and bracteoles; 4. Flower (front view); 5. Calyx; 6. Corolla (side view); 7. Spread-open corolla; 8. Mature stamen; 9. Pistil; 10. T. S. of ovary; 11. L. S. of flower; 12. Fruit; 13. Seed; 14. Floral diagram; 15. Bladder (side view); 16. Bladder (back view); 17. Bladder (front view); 18. L. S. of bladder; 19. Absorptive hair; 20. Hair on body surface

DESCRIPTION

Plants small, slender, prostrate, with erect scapes (Fig. 1). *Stem* mycelium-like, profusely branched, spreading to diameter of 4-5 cm., with numerous very minute bladders. *Leaf* simple, alternate, linear, about 1 cm. long, emerging from underground branches, bright green, base filiform, transparent, with one or two bladders. *Scape* 1·5-4 cm. long, simple, erect, filiform, brownish purple, with sparsely arranged bracts, 1-3-flowered; bracts alternate, simple, up to 0·3 mm. long, purplish, ovate, apex acute, attached by base; upper flowers fertile, lower ones sterile (Figs. 2, 3). *Flowers* 2-2·5 mm. long, subsessile, pink, medianly zygomorphic, hermaphrodite, hypogynous, bracteolate; bracteoles 2, lateral, subulate, and nearly as long as bracts (Fig. 3). *Calyx* about 1 mm. long, purplish, bi-lipped, upper lip obliquely held, acute, lower lip outer, horizontally held, emarginate or with rounded apex (Fig. 5). *Corolla* bi-lipped, upper lip oblong, emarginate, nearly hidden by the upper calyx lip, light pink; lower lip broader, shortly 3-lobed, spurred, deflexed at the middle and held over the throat of spur, pink with a few purple lines; spur horizontal and up-turned, conically tubular, obtuse, protruding beyond corolla lip and light pink (Fig. 6). *Stamens* 2, epipetalous, minute, filament flat, slightly incurved, twisted once; anthers 2-celled, 4-lobed, introrse, spreading open at anthesis. Mature anthers remain connate in front of pistil just below stigma (Fig. 8). *Gynoecium* minute, bi-carpellary, syncarpous, superior; ovary unilocular, thin-walled, ovules numerous on free central placenta; style short, stigma with depressed centre, margins two-lipped, anterior lip protruding much beyond the rim, spreading, papillose; posterior lip shortly conical, erect, and without papillae (Fig. 9). *Fruit* very small, held obliquely upon scape, enclosed in persistent calyx, globular, wall brownish, translucent, opening longitudinally along the anterior side or on both sides (Fig. 12). Seeds very minute, globose, amber-coloured, smooth with reticulate testa (Fig. 13).

The bladder (Figs. 15-18) is very remarkable in its minuteness, beautiful appearance, and simplicity of insect-capturing mechanism. The stalk is comparatively long, uniting with bladder wall on posterior top corner so that the bladder hangs from the stalk. Cells in front of the stalk forming the roof of the bladder are transversely elongated and arranged as a pavement. This is flanked on either side by an oblique fan-like wing of paired vesicular cells, one in each pair with a clavate gland-like cell at tip. At the anterior end bladder wall is extended up into a flat, acute, slightly bent plate. Between this and the posterior wing is another, smaller, oblique wing, of a few cells bent backward. Wall cells between these two wings are also pavement-like. Orifice of bladder very narrow, circular, situated at centre on top between the wings, so that the ascending pavements lead to it. The orifice is continued into the bladder as a conical tube hanging down from the roof and opening at the apex. Around this, the inner surface of bladder wall bears a few 4-rayed absorptive hairs lifted upon slender stalks. The rest of the inner surface is naked. Outer surface of bladder as well as other parts bear short vesicular cells joined to a small cell on the body by a very small cubical cell.

Cyclops, rotifers, and diatoms were found inside many bladders. Absence of sensitive hairs and trap-doors suggests that the victims fall inside the bladder accidentally. The oblique wings and the ascending paths between them lead the victims crawling on the surface, straight into the precipitous orifice. Escape from within the bladder is virtually impossible, because the exit is at the apex of a hanging tube. The 4-rayed hairs at the base of the tube also prevent free access to the exit.

The author is deeply indebted to Prof. N. A. Erady for kindly providing all facilities and for his valuable guidance. The encouragement offered by Sri K. Kesavan Nair is also acknowledged with gratitude.

Govt. Victoria College,
Palghat, Kerala State,
January 29, 1964.

R. VASUDEVAN NAIR

23. PRESERVATIVES FOR FRESHWATER ALGAE

Different algal workers use different fluid preparations for preserving algae for taxonomic purposes. West & Fritsch (1927) recommend 2-4% formalin as a preservative. According to Smith (1950) the simplest preservatives are 2-4% formalin or a mixture of formalin, acetic acid, and alcohol. Prescott (1951) prefers formalin aceto-alcohol and Transeau's Solution with glycerine as preservatives. For preserving the green colour of the algae, Keefe's Solution (Keefe, 1926) is supposed to be the most satisfactory.

It was thought worth while to make a comparison by preserving the same algae in different preservatives for some time. Fresh collections of *Volvox* sp., *Chaetophora* sp., *Oedogonium* spp., *Pithophora* sp., *Cladophora* sp., *Rhizoclonium* sp., *Spirogyra* spp., *Cosmarium* spp., *Closterium* spp., *Nitella* sp., *Euglena* spp., *Trachelomonas* spp., *Anabaena* spp., *Aulosira* sp., *Gloeotrichia* spp., *Oscillatoria* spp., and *Lyngbya* spp. were made for this purpose during September to December 1957 from Bombay and its environs.

Each alga was preserved in triplicate in the following nine preservatives: (1) Transeau's Solution or Six-three-one Solution (six parts water, three parts 95% alcohol, one part formalin), (2) Transeau's Solution with 5 c.c. of glycerine per 100 c.c. of solution, (3) 4% formalin, (4) 4% formalin with 5 c.c. of glycerine per 100 c.c. of solution, (5) 2% formalin, (6) 2% formalin with 5 c.c. of glycerine per 100 c.c. of solution, (7) Formalin-aceto-alcohol (formalin 5 c.c., glacial acetic acid 5 c.c., 50% alcohol 90 c.c.), (8) Mixture of formalin, acetic acid, and alcohol (glacial acetic acid 30 c.c., formalin 65 c.c., and 50% alcohol 1000 c.c.), (9) Keefe's Solution (50% alcohol 90 c.c., formalin 5 c.c., glycerine 2·5 c.c., copper chloride 10 gm., uranium nitrate 1·5 gm.).

The algae were preserved, after a careful microscopical examination, in specimen tubes of borosil glass with cork stoppers, and were examined after five years. It is found that there is not much difference in the preserving capacity of the first eight preservatives mentioned above. However, formalin-aceto-alcohol is slightly better for most of the Chlorophyceae and particularly desmids. 2-4% formalin with or without glycerine slightly dissolves the colonial mucilage of *Gloeotrichia* spp. but apparently has no effect on the mucilage of *Chaetophora* sp. Keefe's Solution is good for preserving the green colour of some of the Chlorophyceae like *Pithophora* sp., particularly the akinetes, *Volvox* sp., *Cladophora* sp., and also of *Euglena* spp., but it gives an unnatural colour to other Chlorophyceae. This solution also gives an unnatural colour to the members of Cyanophyceae. In all the preservatives except Keefe's Solution the material occasionally gets black, possibly owing to the reaction of the cork stopper.

ACKNOWLEDGEMENT

The present work was done in the Botany Department, Institute of Science, Bombay. The author takes the opportunity to thank Professor Ella A. Gonzalves, the then Professor of Botany, Institute of Science, for encouragement.

BOTANY DEPARTMENT,
COLLEGE OF SCIENCE,
NAGPUR 1,
November 11, 1963.

N. D. KAMAT

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THE OPENING OF HORNBILL HOUSE : 13-3-1965

Our new premises, HORNBILL HOUSE, in the Prince of Wales Museum compound, were formally opened by Mr. M. C. Chagla, Union Minister for Education, on Saturday the 13th March 1965. Mr. Chagla expressed keen interest, and commended the work of our Society. He remarked that his own eyes were opened to the wealth of wild life in our country when it was pointed out to him by foreigners who were always puzzled by our own apathy to it. He hoped that the efforts of the Society would succeed is turning the tide and give our young people a real enthusiasm for the treasures at their doorstep.

Mr. Karl Khandalawala, representing the Trustees of the Prince of Wales Museum to whose large-heartedness we owe the permission to build on the present site, also spoke and welcomed the Society kindly as a good neighbour should.

We give below the text of Dr. Sálim Ali's speech delivered on the occasion:

'Shri Chagla, Ladies, and Gentlemen,

'In the unfortunate absence of our President, Shri Cherian, the Governor of Bombay, I have inherited the privilege of welcoming you on this momentous occasion in the history of the Bombay Natural History Society—an occasion for which we have waited, then despaired, then hoped, for over three quarters of a century. The Society was formed in 1883 by a group of 8 residents of Bombay—of whom, it is gratifying to recall, two were Indians—for the purpose of getting together, exhibiting natural history specimens collected by them in their respective fields of interest, exchanging notes and observations, and for generally keeping alight the spark of common interest in the animals and plants and other natural productions around them, and fostering that interest in others.

'This is the seed from which the Society has grown. In the beginning this small group used to meet about once a month in the Victoria and Albert Museum in Victoria Gardens. Later, as more kindred spirits rallied round the nucleus and the collections began to swell, the need for their proper housing and care became urgent. They were offered part of his business premises by Mr. H. M. Phipson in what was then 18 Forbes Street, where Greaves Cotton & Co. now stands. Phipson is really entitled to be called the Father of the Society. Himself an exceedingly keen amateur naturalist, he nursed and nurtured the Society in its early years in a spirit of dedication, and it was during his long term as Honorary Secretary, followed by that of his equally dedicated colleague W. S. Millard, that the true foundations of the Society were laid.

'When Phipson's business expanded he shifted to larger premises just across the street, to No. 6 Apollo Street—later to be renumbered 114. I may mention in parenthesis, particularly for the interest of our Education Minister, who may probably know it already, that this same historic building, unhappily doomed soon to disappear, was at one time, about 1860, the residence of the Chief Justice of Bombay, when the old High Court was within a stone's throw of it. In these premises the Society's offices, library, and museum lived and grew and outgrew for over 70 years. In 1934 its reference collections were, owing to congestion of space, transferred to the then newly completed Natural History wing of the Prince of Wales Museum. Shortage of accommodation even there compelled the office and library to continue in Phipson's premises. This separation of the research collections from the library rendered systematic scientific work extremely difficult and inconvenient as it necessitated constant shuttling between two places separated by several hundred yards of congested public thoroughfare. The last straw came when Phipson & Co. were squeezed out of their flourishing wine business by the advent of Prohibition in Bombay and obliged to dispose of their premises in Apollo Street. Thus orphaned, the Government of Maharashtra came to our rescue by providing funds for hiring temporary but more spacious accommodation for the office and library on Walkeshwar Road, to which, under an arrangement with the Prince of Wales Museum, were also shifted the Society's research collections. It was at this period that negotiations with the Government of Maharashtra and the Union Ministry of Scientific Research for a permanent home for the Society, which had already started much earlier, were intensified. What you see here today is the end-product of those negotiations. On behalf of the Society I would like to express our deepest gratitude to the Governments of India and of Maharashtra State, to the Trustees of the Prince of Wales Museum, and to all those individuals, official and non-official, whose sympathetic interest and efforts have contributed towards this gratifying conclusion.

'A word about the proposed naming of this building as Hornbill House may not be without interest. In the Society's offices in Phipson & Co.'s premises it kept in an adjoining wired-off cabin a Great Indian Hornbill as pet and mascot. This bird lived with us for over 26 years. It became a great favourite with visitors, and almost synonymous with the Society. It seemed to enjoy itself as much as it amused and entertained visitors by clever little antics and games. One of its star turns was to catch in its beak with unerring skill a tennis ball thrown fairly hard at it from a distance of several yards. William, as he was called in deference to his enormous bill, died through misadventure by overeating the wire of his cage. His mortal remains have been perpetuated as the foraging father in the hornbill group exhibited in the bird gallery of the Prince of Wales Museum, as his memory is now being perpetuated in this building of the Society of which he was certainly the most effective Public Relations Officer.

'I shall now outline some of the Society's more important activities and achievements:

'1. The Society has, in the course of its long existence, built up and maintains a collection of zoological material from the Indian subregion which is amongst the finest and most complete in the world. This applies more particularly to Birds and Mammals. This material was acquired through specially organized collecting expeditions and regional faunal surveys conducted by the Society departmentally as well as through the active co-operation of its widespread membership and the financial support of its patrons and well wishers. These collections are available for examination and study not only to members of the Society but to all zoology students and scientific institutions in India and abroad. It is gratifying to mention that many of our collections have formed the basis of important treatises and standard scientific publications throughout the world. The new edition of the FAUNA OF INDIA series volumes on Mammals was made possible by, and is based almost exclusively on, the extensive collections made during the mammal survey of India, Burma, and Ceylon organized and carried out by the Society over several years preceding the First World War. This vast material has since been split up and distributed among various scientific institutions in India and Pakistan as well as abroad, proving for them a veritable windfall. The lesser attention seemingly devoted to the study of plants is far from real. In fact the Society's *Journal* always carries a high proportion of important papers on Indian botany, and we have the privilege of having the distinguished botanist Fr. H. Santapau, a Vice-President of the Society, as our botanical editor and expert consultant.

'That the Society does not also maintain a plant collection is merely in order to avoid unnecessary duplication, it being recognized that there are other institutions in Bombay, e.g. St. Xavier's College, which are better placed for handling botanical material and with whom of course the Society works in the closest association.

'2. The Society publishes a natural history journal, at present three issues a year, which has enjoyed unbroken publication since its inception in 1885. It is now in its 61st volume. It carries popular illustrated articles as well as more technical scientific papers on every branch of the natural history of India and adjoining countries, and of the Oriental region in general. The *Journal* has earned an enviable international reputation for its high standard, and is widely acclaimed the finest natural history journal of the East. It is no exaggeration to say that no research or documentation on Indian animals and plants can be complete, or is indeed possible, without constant delving into this unique repository of scientific knowledge.

'In addition to the *Journal* the Society publishes attractive, well-illustrated books for the popularization of science covering a wide range of natural history subjects. Some of these are displayed here and I would invite you all to inspect them later. These publications are seldom free from financial risk which the Society can ill afford, and often also involve considerable financial sacrifice. They are undertaken not so much with the profit motive as to be in keeping with the primary aims and objects of the Society—namely to popularise and disseminate interest in and knowledge of natural history among the public and thereby enable it to derive the fullest economic benefit and aesthetic enjoyment from the natural products—the flora and fauna with which our country abounds.

'3. Another activity, in which the Society has been engaged for the past 15 years with the financial support of the Government of Bombay (now, of Maharashtra), is a scheme for Nature Study education in schools by means of talks, films, and other visual aids in the classroom, by guided lectures and tours in the Natural History Section of the Prince of Wales Museum, the Zoo and the Aquarium, and also by nature rambles in the beautiful countryside surrounding the City. It is in an activity that has proved its usefulness in arousing interest in school children as well as their teachers. With the better financial assistance we hopefully anticipate, and the facilities that will be available in this new building, we plan to develop and expand this activity to cover other parts of the State as well. It is realized that the lack of interest shown by our young people in nature is largely due to the want of encouragement from their parents at home and from their teachers in school, a disability we aim to remove for future generations. In connection with the Nature Education Scheme the

—Society has published simply written, attractively illustrated, and well-printed booklets on Birds, Mammals, and Plants in English, Hindi, Marathi, and Gujarati. Although priced at only a few Paise per copy, the response from Education Departments, school libraries, teachers, parents, and the general public alike has been disappointing.

'The turnover has been too slow and tardy for us to afford the considerable expansion in the series that was contemplated. The sales of the Hindi editions have, paradoxically enough, been the most disappointing of all. And this despite the fact that our late Prime Minister Pandit Jawaharlal Nehru himself had by personal letters drawn the attention of the Chief Ministers of the Hindi-speaking States to the excellence and availability of the booklets.

'4. An activity which the Society has recently undertaken and developed, and which is of far reaching international public health importance, is the investigation of the problem of bird migration in India and its bearing on the trans-continental dissemination of arthropod-borne viruses. With the financial sponsorship of WHO and the technical co-operation of the Virus Research Centre in Poona and certain virus research laboratories in the USSR, the Society is operating a project for netting and marking migratory birds with numbered, return-addressed aluminium rings to study the origins of the numerous species that visit India in the winter months. Although the project has been running for less than 5 years, a gratifying amount of new information has accumulated about bird movements, their arthropod parasites, and other matters concerning their possible role in the dissemination of viruses affecting man and animals. It is hoped that this fruitful international co-operation received by the Society will enable it to make a significant contribution to the knowledge of the public health aspect of bird migration, in addition to procuring factual data on a subject which until recently had received very little serious attention from biologists in India.

'5. The Society has been recognized by the University of Bombay as a guiding institution for post-graduate research in Field Ornithology. Zoology students who have done their B.Sc. can now obtain their M.Sc. degree through research under the recognized guide, and it is hoped that the recognition will soon be stretched to cover a doctoral degree as well. With its established ornithological tradition, excellent research collection of birds, and its excellent zoological library the Society feels adequately equipped to function as the central school of ornithology in India. Given funds for awarding scholarships to promising zoology students there is no reason why we should not attract the right type of persons from all over India and build up a cadre of qualified teachers and researchers in ornithology. The lack of teachers is the chief factor that is retarding nature study teaching and biological field research in India today, especially vertebrate ecology--also other branches of field natural history as distinct from the study of systematics for which facilities already exist, e.g. at the Zoological Survey of India with which the Society maintains close liaison.

'Thanks to scholarships awarded by the Council of Scientific and Industrial Research, we have two post-graduate students working at present on different facets of "The Role of Birds in our National Economy". The lack of jobs and opportunities for qualified ornithologists in India makes it difficult to attract suitable zoology students to this line of study without offering them reasonable inducement in the way of stipends.

'An application for such scholarships has been submitted by the Society through the University of Bombay to the Central Ministry of Education, which it is hoped will receive favourable consideration.

'In a country like ours which leans so heavily on agriculture and forestry, proper research on the economic aspects of bird life is of very great importance. The status of bird species, whether harmful as crop destroyers or beneficial as enemies of pests, needs to be scientifically assessed before any control measures can be undertaken. This is a fact which has been little recognized in India, though in the more advanced countries of the West such research is paying rich dividends. But, unless we have trained and competent biologists available for undertaking the meticulous type of field and laboratory research which Economic Ornithology demands, we shall continue to lag behind.

'6. From pre-Independence days the Society has been seriously concerned about the preservation of our vanishing wild life and has played a leading part in the matter of Nature Conservation. The Indian Board for Wild Life which is now the central quasi-governmental advisory organization for the States on policy matters connected with nature conservation—functioning under the Central Ministry for Food and Agriculture—owes its formation to the spade work done in earlier years by the Bombay Natural History Society and the dedicated efforts of some of its far-sighted veteran British members, to whom a grateful tribute is due. Unfortunately the Indian Board for Wild Life as presently constituted and functioning is a less active and potent body than the Society would wish. But it is a step in the right direction, and we are exploring ways and means through the Planning

Commission for making it a more effective organization. The Society has been largely responsible for framing, drafting and getting through the Legislatures of undivided Bombay State, the Wild Animals and Wild Birds Protection Act, 1951. This eclectic Act is based on some of the best features embodied in similar acts in more advanced countries of the world, rationally adapted to Indian conditions. It has been recognized as a model of its kind and recommended by the Indian Board for Wild Life for adoption by all the other States of the Indian Union, with modifications to suit their local conditions.

'This is an outline of a few of the activities and achievements of the Society. With a permanent home which, thanks to the Government of India and the Trustees of the Prince of Wales Museum, we can at long last call our own, and with the additional facilities in the way of accommodation, equipment, and opportunities—and, let us hope, funds—the Society can look forward with confidence to a long future of service to the country and to science. To achieve this will be its continuing endeavour.'

* * * *

Replying to Dr. Sálim Ali, Mr. M. C. Chagla said that as Union Minister for Education he would do all that he could to further the cause of nature education in this country.

The Honorary Secretary proposed a vote of thanks.

After the meeting the visitors were shown round the rooms of the Society where the publications and collections of the Society were displayed.

Notes and News

Orchid Club of Bombay

We are very glad to welcome the Orchid Club of Bombay, which has recently entered into the second year of its existence. It is surprising that in a country whose rich stores of native orchids have been exploited for years by enterprising foreigners there has so far been comparatively little local interest. Started by a small group of enthusiasts, the club seeks to create a love for and to spread the knowledge of orchids, to help its members in procuring and caring for them, and to conserve the orchids growing in our forests. To avoid the attachment of a prestige value to membership and to make it possible for all interested persons to become members the subscription has been kept low. Enquiries for further information should be addressed to: Mr. S. Abdulali, Honorary Joint Secretary, Orchid Club of Bombay, 'Sahara', Quarry Road, Devnar, Chembur, Bombay 71-AS.

* * *

Indian Association of Biological Sciences

A new Association, Indian Association of Biological Sciences, was formed during the combined 51st-52nd session of the Indian Science Congress Association at Calcutta in January 1965. A steering Committee consisting of Profs. B. R. Seshachar, T. S. Sadasivan (Secretary), Sivatosh Mookerjee, and Drs. B. Mukerji, H. B. Tewari, B. S. Chauhan, with Prof. P. Maheshwari as Chairman, was elected to formulate the detailed scheme of the Association, the main aim of which will be to create a common forum of Indian Biologists and to integrate the research activities of biologists working in Medicine, Agriculture, Veterinary, Botanical, and Zoological sciences, and the borderline fields of Biochemistry, Biophysics, Biometrics, etc.

The annual subscription has been tentatively fixed at Rs. 10. Intending subscribers should send their first subscription to the Treasurer, Dr. B.S. Chauhan, Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-12. Other communications may be addressed to either Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras-5 or Prof. P. Maheshwari (Chairman), Professor and Head of the Department of Botany, Delhi University.

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THE SOCIETY'S PUBLICATIONS

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The Book of Indian Animals, by S. H. Prater. 2nd (revised) edition. 28 plates in colour by Paul Barruel and many other illustrations. **Rs. 30**
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The Society will gratefully accept back numbers of the *Journal,* particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.
Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

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The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50) if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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H. SANTAPAU, S.J., D. E. REUBEN,
ZAFAR FUTEHALLY, & J. C. DANIEL

AUGUST 1965

Rs. 15

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Contributors of scientific articles are requested to assist the editors by observing the following instructions :

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

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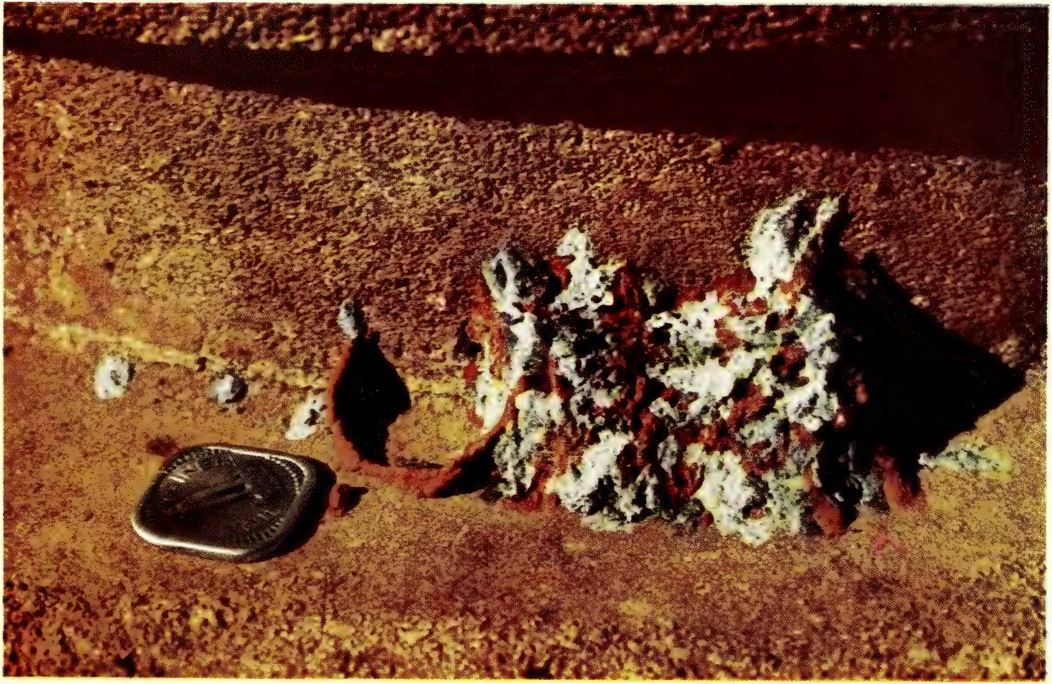

Nest of *Eumenes p. pyriformis* 1. 18/xi/63 ; 3 days after desertion. Central cell is I ; cell to left an abortive II ; cell to the right, the last begun and the definitive II. The coin is 1·87 cm. square with rounded corners.

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1965 AUGUST Vol. 62 No. 2

Normal and abnormal Nests of *Eumenes emarginatus conoideus* (Gmelin) including Notes on Crépissage in this and other members of the genus (Vespoidea, Hymenoptera)

BY

S. D. JAYAKAR AND H. SPURWAY

Genetics and Biometry Laboratory, Government of Orissa, Bhubaneswar

(*With three plates*)

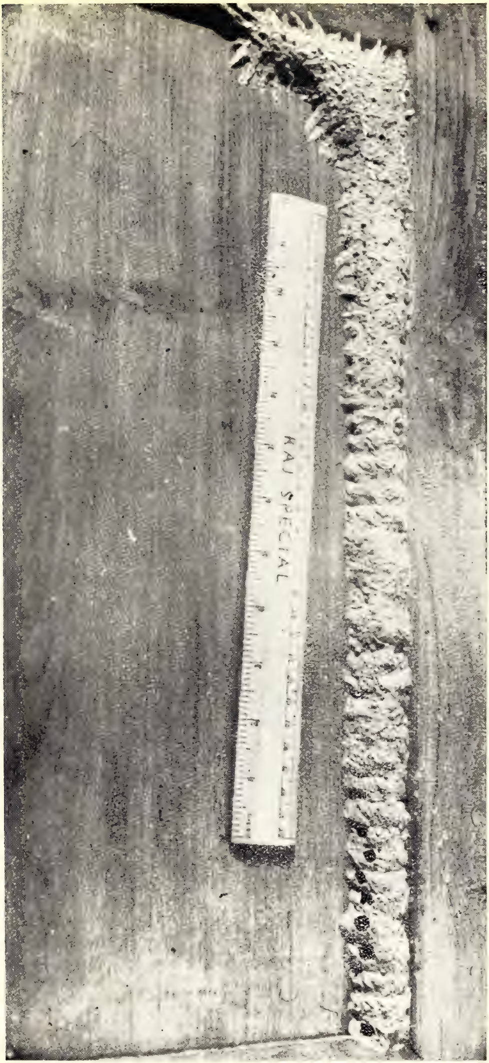
Eumenes emarginatus conoideus (Gmelin) is a fairly common domestic wasp in Bhubaneswar, and all nests here described of this and other species were built indoors, or in roofed-over parts of recent concrete buildings.

Maxwell-Lefroy (1909) and Dutt (1913), who were colleagues and worked on the same material, have written on the biology of *E. e. conoideus* which, following Bingham (1897), they called *E. conica* Fabricius. Iwata (1964), in his recent notes on this subspecies from Thailand, quotes and confirms these authors that its maximum nest-size is 10 cells.

The Table on p. 199 gives data concerning the 12 wasps of this subspecies which we have observed between 23/viii/62 and 9/x/64. Wasps are labelled with *c* followed by a so-called Arabic (or international) numeral; cells within a nest with Roman numerals. Two females (*c*6 and *c*10) were observed during the process of deserting one aggregate of cells and selecting the site for a second, which is designated by the same wasp number followed by a prime (e.g. 6′). Considering wasps *c*2—*c*12 (*c*1 being interrupted) and the thirteen nests they constructed, only three (5, 6, and 10) were completed in the sense that not only was no cell left unfinished or open, but at least the later cells were covered with the granular daubing to which we wish to restrict Roubaud's (1916) term *crépissage* [Jayakar & Spurway, in press, to which we refer for elaboration of our references to *E. campaniformis esuriens* (Fabricius)]. The mothers of two of these nests confirmed their completeness by immediately selecting a second site and beginning a new construct within 2½ hours of finishing the crépissage.

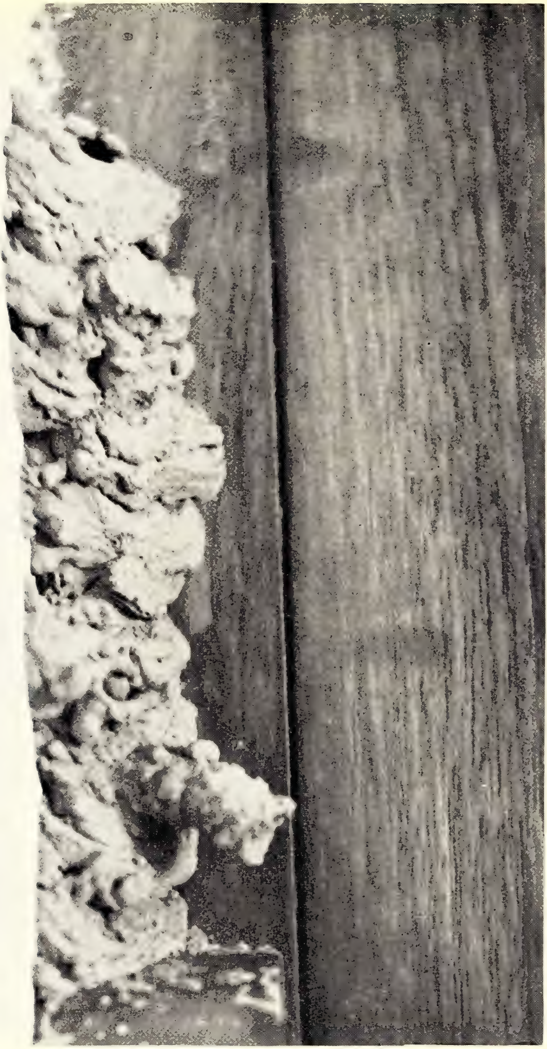
Nest 9 was built on a white-washed wall and round the edge of a cylindrical wooden base for a latch-type door stop. This was 7.5 cm. in diameter, and the first 12 cells of the nest extended upwards round half of its circumference. The remaining 9 were laid down in 3 rows entirely on the wall above the wooden fitment. The giant first nest of *c*10 is shown in Plate II. Cells I to XLI were very standardized in size and shape, though wasps of both sexes emerged from them. They were built one above the other on a wooden shutter in the angle between convex edges of the frame and the flat panel. The mother was marked with paint during the construction of cell XX. The remaining five cells, which were unusually long and narrow, were fitted in somewhat irregularly in the upper corner. The first 3 cells of nest 11 were also partly on a wooden fitment and partly on the vertical wall to which it was attached. The remaining 26 were built entirely on the surface of the wall above it, the mother being painted during the construction of cell XV. These three nests show that a maximum of ten cells is not characteristic of the species at least in this part of its range.

We think it coincidental that both the second nests 6′ and 10′ were the only ones we found built on cane. The cane on which 6′ was built was about 14 mm. in diameter, so 6′ like 6 consisted of the half pots characteristic of the species. However 10′ was built on a partially burnt area of a waste paper basket woven of vertically round canes 5 mm. in diameter and horizontal ribbons. The first cell of 10′ was a complete pot. This was begun, as is usual, as a pair of brackets which were smoothed out and thickened inwards until they were joined to make a floor which was not quite complete, but its outer surface was moulded into the basket work [compare Olberg 1959, p. 122, upper left, for similar work by *E. pedunculatus* (Panzer)]. Thus, one marked individual (*c*10) was seen to construct both complete and half pots, and *E. e. conoideus* must be added to the list of species which are known to have this architectural versatility. The five later pots had similar floors where these were supported by the basket-work, but they were incomplete as they were built overlapping at least one earlier cell. Wasp *c*10 was also seen to twice revisit her first nest after she had built on her second site. The first of these visits was on 21/viii, 5 hours after she deserted nest 10, while she was building cell 10′ II, but the second was five days later (26/viii). On this second visit, however, she did not land, but only



First nest of *Eumenes emarginatus conoideus* 10. 26/viii/64; after emergence had begun.

(*Photo : Dr. J. M. Poehlman*)



Nest of *Eumenes emarginatus conoideus* 12. 13/ix/64. No further loads were brought. The nest is 10–11 cm. high.

(*Photo : Prof. T. A. Davis*)

hovered over nest 10 before flying straight to nest 10′ on what was apparently an inspection visit first thing in the morning. As this was the last day she was seen, this visit to nest 10 might have been pathological, e.g. due to senility. On nest 10′, she put down several daubs before completing cell 10′ VI which had been left unfinished due to sudden rain the night before. She was not seen after the oviposition made on the completion of 10′ VI. The presence of the egg was checked. A wasp visited nest *c*7 on 1/iv which, in the light of the behaviour of the marked *c*10, was probably the mother. Iwata's (1964, p. 334) observation that a wasp was ' plastering a mud coat over the entire surface ' of a 3-celled nest in which all the larvae were already pre-pupae in cocoons suggests that *E. e. conoideus* wasps may sometimes even return to work on their earlier nests.

Female *c*10 thus laid 52 (46+6) eggs to our certain knowledge, for there is no suggestion of any pathological behaviour concerning the exceptionally rapid construction of her first nest. Dr. Iwata (personal communication) tells us that this may be the record number laid by a solitary wasp, and suggests that tropical species have a greater fecundity than their better known temperate relatives (Iwata 1942). If this is confirmed, these nest-building wasps thus differ from birds in whom clutch size increases with latitude.

The range of work speeds was striking. Though most wasps averaged about one cell built, laid in, provisioned, and sealed a day, *c*10 rose to an average of 1·84 and *c* 6 sank to 0·42, *but* for both wasps the exceptional speeds were for only *one* of the two constructs which we saw them build. Wasp *c*6, when building nest 6′, frequently missed a day without bringing a load, and once two days. These absences always left a cell half built, or incompletely provisioned. They were not due to inclement weather and during them she did not return to her already crépissaged first nest.

Crépissage has not, to our knowledge, previously been described in detail for *E. e. conoideus*. This, in wasps of the genus *Eumenes*, consists of finishing off a group of cells by completely covering them with discretely applied lumps of mud so that the construct is left with the appearance of a minute recent mountain chain, whose subsidiary ranges of peaks extend from the cells to the substrate on which these were constructed. As the loads of mud are not worked together as they are put down, the texture remains granular. Though such a structure must be porous, we have once seen a *conoideus* build a vault under her crépissage as is usually done by *E. c. esuriens*. Iwata (1942) considers these vaults to be air-spaces which buffer the cells against temperature changes. We consider that they may also provide protection from parasites such as chrysid cuckoo-wasps who bore into the walls of sealed cells to oviposit. We have seen both *conoideus* and *esuriens* leave the earlier cells naked in large nests, e.g. *c*10 (Plate II). Finally, the crépissage of *esuriens* is made exclusively with the same mud as that with which she builds her cells, in this region red and lateritic. However, all the crépissages we have seen by *conoideus* have been finished-off with some loads of sandy soil so laid down on the ridges, that, by simulating snow, they increase the resemblance to mountains. In the only crépissage we have seen constructed by an *E. pyriformis pyriformis* (Fabricius), ash and cinder dust was used for this finishing (Plate I).

Returning to the Table on p. 199 we note that though several wasps built unexpectedly large nests, two, *c*2 and *c*4, were deserted before even one cell was properly sealed, and two more nests (*c*3 and *c*8) were small. Two of these nests also involved disturbances of the normal sequence. Wasp *c*4, who provisioned but did not seal the only cell she built, put down five loads constructing five abortive brackets at four other sites before adding to the single bracket she had made on the site that had been her first choice. Such intention movements before beginning nest building, which we have also seen made by *E. c. esuriens*, may be no more pathological than they are in birds, but that *c*3 provisioned and sealed her cell I without oviposition is surely a miscarrying of the sequence.

More bizarre is the history of nest 12 (Plate III). This nest was built on the frame and jamb of a window above the stop of the shutter that was the pair of that on which nest 10 had been started exactly six weeks before. It is possible, as the species is not very common, and perhaps likely, that *c*12 was the daughter of *c*10. One abortive bracket of probably two loads was made outside the area photographed. Cell I was small and was left without a lid or an egg overnight. A lip is not an essential feature of a *conoideus* pot and was often omitted by *c*10. However, it was possible that for wasp 12 cell I was unfinished as she did not lay in it. Next morning she first confirmed this interpretation by constructing a lip, however she immediately confounded it by continuing working, putting at least 5 loads on this lip (she was not watched continuously) enlarging it into a little tube which she reinforced on the outside. She spread out the end of this funnel into a lip and sealed the opening with a little knob. Thus cell I had both an abnormal form and was sealed empty. She immediately built cell II, above cell I, continued work on the lip until it was a funnel, and then spent four minutes approaching her abdomen to its mouth and removing it without actually inserting it. It was then realized that she had previously made similar but more trivial abortive egg-laying movements while building both funnels. Her movements suggested that she had not received the proper stimulus to oviposit, not that she was egg-bound. Her behaviour is in contrast to that we have described in an *E. c. esuriens* individual, *e*5, who on several occasions first thing in the morning during provisioning laid an egg. These took a long time and sometimes seemed to necessitate a struggle. These exceptional ovipositions were, we think, stimulated by some change in the egg laid on the completion of the cell. Wasp *c*12 extended the mouth of II into a tube 1·7 cm. long which curved downwards and without sealing this she began cell III. She worked on this and the tube alternately until the cell was complete and fairly normal, and the tube 2·5 cm. long, and the awkward way it curved downwards resembled pictures of the temporary flight tubes constructed by *Oplomerus spinipes* (Linnaeus) [compare Plate III with Olberg (1959) pp. 140-149].

Next day, *c*12 pathologically added to lip III, and built IV including excrescences which were later added to and became the first two brackets of V. This may not itself be pathological but merely a consequence of the cells being distorted in shape ; *c*10, when fitting the later cells of her great nest into the corner of the shutter, often left well-worked ridges which she later extended, often with gross modification, to become the brackets of the next, or even later, cells. *c*12 was next etherised and painted, and did not return that day. Next morning she thickened lip IV and continued building V above it. Again she made what later was used as the first bracket of VI, but succeeded in ovipositing in V.

Though this, her first egg, was present at 13·05, she did not bring her first prey until next day when she inserted the bluish green semi-looper Noctuid larvae which were the prey used, apparently exclusively, by *c*10, *c*11, and *c*12. Unfortunately she put larvae into the egg-less cells III and IV as well as in V, and then sealed the egg-less IV only. She then built VI so that its walls enclosed the open mouth of V, from which a prey walked out into the unfinished cell and was collected by the observers.

Next day, she apparently pushed another larva back into V before it had completely escaped, and continued cell VI, finished it, and oviposited. The cavities of cells V and VI were thus continuous. She provisioned cell VI apparently normally, sealed it and built cell VII. She then drew her abdomen up to the lip and relaxed it repeatedly for over a minute. After this frustration, she extended the lip for 1 cm. without curving it in any way. The mud work of this tube was exceptionally coarse and the loads were extended on to the cell walls of VII. She immediately laid an egg in the mouth of tube VII, doubtless as deep as she could reach with her abdomen.

Not till next day did she try to insert prey into this tube. This prey both dislodged the egg and itself lodged in the tube.

She sealed VII and built VIII, again above it, oviposited, and provisioned. She may have had trouble with her prey and was once seen standing on her hind legs on tube II while maxillating a caterpillar. There is a distinct suggestion in our notes that either *c*12 did not render her prey as passive as other wasps, or more likely they could not be inserted so deftly into these cells which were more abnormally shaped than has been emphasised, but which is well shown in Plate III. Cell VIII was sealed by the end of the day. Next day she built IX above VIII, laid, and put in at least one larva. A chrysid was then seen on the nest. *c*12 then put down a few daubs and began crépissage. She also dropped at least one load, and took away another not putting it down. A chrysid made another visit, and then two more loads were added to the crépissage. Next morning she made at least two loadless visits, on the second of which she was followed by a sarcophagine fly who, when the wasp had left, oviposited or larviposited in IX. A chrysid again arrived, four minutes later *c*12 arrived, and immediately left the nest, and for the next 16 minutes hovered over similar furnishings on the verandah, never returning to the construct. She thus made a definitive desertion due to parasitization. Next morning ants removed the prey from III and a spider was captured carrying an apodous larva, perhaps of one of the parasites. A wasp emerged, apparently from VII, not from VIII which was the only normally filled cell. As has been noted, all the cells were contorted in shape.

Roubaud (1916) had discussed such dysgenic sequences of behaviour in the African *E. tinctor* Christ, and interpreted them as responses to the frustrations due to suboptimal microclimates, either seasonal or geographical. We have discussed elsewhere Roubaud's examples and those we have observed in *E. c. esuriens.* Such behaviour seems much more frequent in *conoideus* than in the commoner *esuriens* in this locality; however, we have yet to see one female *esuriens* making two constructs or any containing more than thirteen cells. This supports Roubaud by suggesting that *conoideus* is in some way at the edge of its ecological range, where, as would be expected on some theories of population expansion, some individuals, perhaps genetically exceptional, do exceptionally well, while other individuals are exposed to strains to which they are unequal.

However, *c*12 seemed to suffer from an internal insufficiency so that, though not egg-bound, she only made low intensity attempts to oviposit at the appropriate time in the cycle. Whether or not this was in some way due to the environment (e.g. through nutritional inadequacy) is irrelevant to the demonstrations it gave of the role played by such actions in a cycle of instinctive activities. Oviposition, perhaps because the wasp reacts to the presence of an egg, or because the action of laying provides Sherringtonian proprioceptive consummatory stimuli, inhibits one phase of the cycle (in this example mud working), and therefore permits the initiation of the next phase (in this example provisioning). However, the behaviour of *c*3 did not conform to this Lorenz-Tinbergen instinct theory analysis. After she had failed to lay in cell I she pro-

TABLE

PARTICULARS OF NEST-BUILDING OF THE WASP *Eumenes emarginatus conoideus*

Nest	Situation of nest	Height above ground level (cm.)	No. of surfaces			Date found	Condition when found	Date deserted	Condition when deserted	Temperature during construction	
			wood	masonry	others					Maximum	Minimum
*c*1	o	96	2	..	..	23/xi/62	II begun	mother collected	..	29·1	16·3
*c*2	o	61	..	2	..	23/xi/	selecting site	25/xi/	I open	29·7	16·2
*c*3	o	61	..	2	..	18/ii/63	selecting site	21/ii/	III open (did not lay in I)	35·3	15·9
*c*4	i	152	1	1	..	5/iii/	abortive brackets	7/iii/	I open	34·7	16·6
*c*5	o	115	..	2	..	14/vi/	V open	21/vi/	X sealed crépissage complete	37·2	19·6
*c*6	o	280	1	..	metal 2	6/ii/64	I begun	10/ii/	IV sealed crépissage complete	31·1	18·6
6′	i	66	..	..	cane 1	10/ii/	selecting site	5/iii/	X open part nest dissected 7/iii	36·8	16·0
*c*7	o	119	1	2	..	23/iii/	I open	27/iii/	IV open	38·0	22·0
*c*8	i	70	2 (1 concave)	..	..	17/v/	selecting site	19/v/	II unfinished	40·1	23·6
*c*9	o	679	1 (convex)	1	..	25/v/	XI begun	?	XXI unfinished	40·4	24·2
*c*10	o	126	4 (3 convex)	..	..	25/vii/	selecting site	21/viii/	XLVI sealed crépissage complete	33·6	23·6
10′	i	51	..	..	cane 1	21/viii/	selecting site	26/viii/	VI open	32·1	24·0
*c*11	i	312	1	1	..	21/viii/	XV begun	1/ix/	XXIX open	32·2	24·0
*c*12	o	188	2	1	..	5/ix/	abortive bracket	14/ix/	IX open (did not lay in I, II, III, IV, and abnormal construction)	33·0	23·6

NOTE. i = indoors; o = outdoors roofed-over visioned and sealed the cell normally. The oviposition was simply dropped from this cycle, and the absence of either the egg or the proprioception of ovulation provoked no visible reaction in the wasp. The entirely different consequences of the two failures perhaps lie in differences in the nervous processes which produced them.

The other abnormal actions of *c*12 seemed secondary to this failure to cease building and oviposit, and were as would be expected if her behaviour was instinctive. It was not surprising that all open cells stimulated, or released, the insertion of prey, and that she had no capacity to choose between several, because only in exceptional circumstances will more than the relevant one be present. Similarly, after the consummatory stimulus of sealing one cell had released the building of walls, is it surprising that an open cell mouth in the middle of the new cell floor provided no releasers to inhibit this building or to alter the form it took, even though the wasp reacted to this open mouth when prey escaped from it? As has so frequently been pointed out, the instinctive nature of an activity reveals itself in situations where the activity miscarries.

Wasp *c*12 seemed to be recovering from her primary disabilities when parasitization stimulated her to desert this largely abortive nest, exactly as it stimulates normal nests to be deserted by normal *E. c. esuriens*.

ACKNOWLEDGEMENTS

We are very grateful to Dr. J. M. Poehlman and Prof. T. A. Davis for photographing our nests, and to Dr. J. van der Vecht for identifying specimens.

SUMMARY

Thirteen nests of *Eumenes emarginatus conoideus* are described. Three were larger than any previously recorded. One was deformed, apparently primarily because of a failure in the female's egg-laying behaviour. The crépissage of this species is described, and compared with that of *E. p. pyriformis* and *E. campaniformis esuriens*.

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Further Contributions to the Botany of Dangs Forest, Gujarat

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ABSTRACT

An account of additional plants, collected from Dangs Forest, is given in this paper.

INTRODUCTION

The information about the flora of Dangs Forest so far is very meagre. Cooke (FL. PRES. BOM. 1901-08) occasionally cites locality 'Dangs'. The senior author (*J. Gujerat Res. Soc.*, 1954, **16** : 285-320 and 1955, **17** : 1-59) published an account of flowering plants occurring in Dangs Forest, based on collections made at Waghai and Unai. In Blatter Herbarium, there are several sheets of plants collected from various parts of the Dangs, e.g. Sunda, Ahwa, Subir, Kasarbari, by the senior author and his students, the junior author being one of them. In this paper an additional list of plants, not enumerated earlier, is given. In the list we have also included some plants when our observations for those plants are different from the ones published earlier.

The general pattern of vegetation in the forests at Ahwa, Sunda, Kasarbari, etc. is almost the same as that described for Waghai and Unai by the senior author ; hence no account is given here.

The names of the plants are mostly the same as those given in Cooke's FLORA ; where the name is changed, we give first the name which, according to us, is correct. The name in Cooke's FLORA, then, is given as synonym. The plants marked with asterisks are not mentioned by Cooke.

ENUMERATION OF PLANTS

DILLENIACEAE

1. **Dillenia pentagyna** Roxb.

Occasional in the forests at Ahwa and Sunda. Noted on 20.xii.63.

TAMARICACEAE

2. **Tamarix ericoides** Rottl.

Very common and abundant, gregarious, in river beds. Flowers bright pink to purple. Sunda: *Shah* 10685.

MALVACEAE

3. **Hibiscus furcatus** Willd.

Occasional in the undergrowth of forests, in fruit. Sunda: *Shah* 10709; Kasarbari: *Shah* 10698-99.

4. **Hibiscus lobatus** (Murr.) O. Kuntze (*Hibiscus solandra* L'Hér.)

Occasional in shade in open forests, in fruit. Sunda: *Shah* 10708; Pimpri: *Asrana* 3106.

5. **Hibiscus vitifolius** Linn.

Rare; flowers sulphur-yellow. Subir: *Asrana* 2831, 2840; Waghai: *Asrana* 3017.

6. **Sida glutinosa** Cav.

Fairly common in open forests. Flowers yellow. Unai: *Santapau* 17271; Ahwa: *Shah* 10679; Sunda: *Shah* 10696; Waghai: *Santapau* 19673; Dangs: *Asrana* 5431.

TILIACEAE

7. **Grewia abutilifolia** Vent.

Rare, in fruit. Sunda: *Shah* 10711; Subir: *Asrana* 2923.

LINACEAE

8. **Linum mysorense** Heyne

Common and abundant in open grass fields. Flowers yellow. Ahwa: *Santapau*: 19397-99; *Asrana* 2941; Subir: *Asrana* 3162.

MALPIGHIACEAE

9. **Aspidopteris cordata** (Heyne) Juss.

An extensive climber, in flower, abundant in the forest at Susurda, about 10 miles from Waghai. *Santapau* 19729-30.

PAPILIONACEAE

10. **Desmodium heterocarpum** (Willd.) DC. [*Desmodium polycarpum* (Poir.) DC.]

Common in shade along paths in the forest. For the nomenclature of this plant, see Shah in *J. Bombay nat. Hist. Soc.*, 1963, **60**(1): 296. Waghai: *Santapau* 19650; *Panthaki* 1744; *Asrana* 3036.

11. **Desmodium triangulare** var. **congestum** (Prain) Santapau (*Desmodium cephalotes* Wall. var. *congestum* Prain)

Fairly common, at times gregarious, along paths in the forest and river banks. Flowers creamy white. Waghai : *Santapau* 19323 ; Pimpri : *Santapau* 19925 ; Sunda : *Shah* 10742.

12. **Desmodium triquetrum** (L.) DC.

A fairly distinct species on account of the winged petioles. Flowers bright purple. Waghai : *Santapau* 19966 ; *Panthaki* 1717, 2332 ; *Asrana* 2994.

13. **Desmodium velutinum** (Willd.) DC. [*Desmodium latifolium* (Roxb. ex Ker) DC.]

Occasional in the undergrowth of the forest. For the nomenclature of this plant we have followed Schubert in *J. Arn. Arbor.*, 1963, **44** : 222. Sunda : *Shah* 10707.

14. **Moghania macrophylla** (Willd.) O. Kuntze (*Flemingia congesta* Roxb.)

In Blatter Herbarium there is one sheet of this species (No. 27837) without collector's name, collected from Waghai in February 1919.

*15. **Moghania praecox** var. **robusta** Muk.

Fairly common on the edges of the forest. Flowers creamy yellow, tinged with red. Waghai : *Panthaki* 2511-13 ; Pimpri : *Asrana* 5394.

*16. **Uraria rufescens** (DC.) Schindler

Common in the undergrowth of the dense forests. Flowers bright purple. Pods typical. Waghai : *Santapau* 19741 ; *Panthaki* 1727 ; *Asrana* 2995 ; Unai : *Santapau* 17339 ; Ahwa : *Shah* 10676.

CAESALPINIACEAE

17. **Cassia obtusifolia** Linn.

Rare, in shade along paths in thin forest. Kasarbari : *Shah* 10692.

LYTHRACEAE

18. **Rotala indica** (Willd.) Koehne (*Ammannia peploides* Spr.)

Rare, in the cultivated fields. Ahwa : *Shah* 10712.

CUCURBITACEAE

19. **Trichosanthes bracteata** (Lamk.) Voigt (*Trichosanthes palmata* Roxb.)

A common twiner on edges of the forest. Waghai : *Santapau* 19927.

RUBIACEAE

20. **Anotis rheedei** Hook. f.

Common among grasses and in shade along paths in the forest. Flowers minute, white. Waghai: *Santapau* 19160; *Asrana* 3004; Ahwa: *Santapau* 19351-52; *Asrana* 2811.

21. **Wendlandia exserta** DC.

Common, scattered or gregarious, along river banks; also found on the edges of forest along Ahwa Ghat Road. Flowers white or pale blue. Sunda: *Shah* 10717-18.

COMPOSITAE

22. **Acanthospermum hispidum** DC.

An occasional weed along roadsides at Ahwa and Waghai. Ahwa: *Saldana* 6788.

23. **Adenostemma lavenia** (Linn.) O. Kuntze (*Adenostemma viscosum* Forst.)

Occasional in patches near watercourses, in river bed. Waghai: *Shah* 10762-63; *Asrana* 5263.

24. **Blumea eriantha** DC.

Common along roadsides at Ahwa; seen on 20.xii.63.

25. **Blumea lacera** (Burm. f.) DC.

Abundant along railway lines and in open forest. Flowers yellow. Unai: *Santapau* 17362; Waghai: *Santapau* 18441.

26. **Blumea membranacea** DC.

Occasional in stony ground in dry beds of streams at Ahwa; seen on 20.xii.63.

27. **Blumea obliqua** (Linn.) Druce (*Blumea amplectens* DC.)

Rare, in moist places at Waghai. Flowers yellow.

28. **Sclerocarpus africanus** Jacq.

Fairly common in hedges along roadsides and on edges of forest. Flowers yellow. Waghai: *Asrana* 2230.

29. **Vernonia divergens** Edg.

Dangs: *Asrana* 5491.

PRIMULACEAE

30. **Anagallis pumila** Sw. (*Centunculus tenellus* Duby)

Fairly common on earth bunds and in cultivated fields. Flowers white, often tinged with pink. Ahwa: *Shah* 10765.

APOCYNACEAE

31. **Wrightia tomentosa** R. & S.

A common tree in the forests at Ahwa, Sunda, and Kasarbari; seen only in fruit. Kasarbari: *Shah* 10682; Waghai: *Irani* 149.

ASCLEPIADACEAE

32. **Holostemma annulare** (Roxb.) K. Schum. (*Holostemma rheedianum* Cooke, non Spr.)

An occasional twiner, in fruit. Ahwa: *Shah* 10767; Pimpri: *Santapau* 19313; Waghai: *Irani* 271.

33. **Marsdenia tenacissima** (Roxb.) Moon

Fairly common in the undergrowth. Flowers and fruits not seen. Waghai: *Santapau* 19257; *Irani* 153.

34. **Telosma pallida** (Roxb.) Craib (*Pergularia pallida* W. & A.)

Only one plant seen in hedge near the office of the Forest Department. Waghai: *Irani* 148.

GENTIANACEAE

35. **Exacum pumilum** Griseb.

Common in low grasses at Ahwa. Flowers deep blue or bluish purple. Ahwa: *Santapau* 19400.

36. **Canscora concanensis** Clke.

Abundant in open ground among grasses on rocky slopes along paths in the forest. Flowers rose-coloured. Subir: *Santapau* 19418; *Asrana* 2817; Waghai: *Santapau* 19263; Ahwa: *Santapau* 19300.

CONVOLVULACEAE

37. **Cuscuta reflexa** Roxb.

Dangs: *Asrana* 5409.

38. **Ipomoea arachnosperma** Welw. (*Ipomoea pilosa* Sw.)

Common and abundant. Flowers deep pink. For nomenclature see Verdcourt in 1963, FL. TROP. EAST AFR. (Convolvulaceae) p. 112. Waghai: *Asrana* 3060.

39. **Ipomoea hederifolia** Linn. (*Quamoclit coccinea* auct. non Moench.)

An occasional twiner on hedges near Waghai. Flowers deep red. Noted on 24.xii.63. For nomenclature see Verdcourt in 1963, FL. TROP. EAST AFR., p. 132.

40. **Ipomoea sinensis** (Desr.) Choisy [*Ipomoea calycina* (Roxb.) Clke.]

A rare plant, in hedges near Unai. Flowers creamy white. For nomenclature see Verdcourt in 1963, FL. TROP. EAST AFR., p. 101.

*41. **Ipomoea triloba** Linn.

An occasional twiner on hedges near Waghai. Flowers bright pink or rose-coloured; corolla about 18 mm. long. Noted on 24.xii.63.

SCROPHULARIACEAE

42. **Kickxia ramosissima** (Wall.) Janch. (*Linaria ramosissima* Wall.)

Dangs: *Asrana* 5236, 5464.

ACANTHACEAE

43. **Barleria cristata** Linn.

Dangs: *Asrana* 5471.

44. **Carvia callosa** (Wall.) Bremek. (*Strobilanthes callosus* Wall.)

Occasionally in large patches along paths in the forest. Ahwa-Subir road: *Asrana* 3214.

45. **Dipteracanthus patulus** (Jacq.) Nees (*Ruellia patula* Jacq.)

A few patches seen in the river beds. Flowers pale purple. Sunda: *Shah* 10716-17, 10739-40.

46. **Justicia gendarussa** Burm. f.

Cultivated as a border plant at Ahwa.

47. **Justicia procumbens** Linn.

Dangs: *Asrana* 2847.

48. **Thelepaepale ixiocephala** (Benth.) Bremek. (*Strobilanthes ixiocephalus* Benth.)

Dangs: *Asrana* 5441.

LABIATAE

49. **Anisomeles heyneana** Benth.

Occasional in the undergrowth of forests and on the edges of cleared forests. Flowers creamy white, tinged with pink. Waghai: *Santapau* 19991; also seen at Sunda on 22.xii.63.

50. **Leucas martinicensis** R. Br.

About 1·5 m. tall among grasses, near river at Pimpri. Pimpri: *Santapau* 20156-9; Subir: *Asrana* 3198.

AMARANTHACEAE

*51. **Achyranthes aspera** Linn. var. **porphyristachya** Hook. f.

Common, in loose patches, in the undergrowth of thin forests. Ahwa : *Shah* 10675.

*52. **Alternanthera ficoidea** R. Br.

An occasional weed along roadsides. Waghai : *Shah* 10760.

EUPHORBIACEAE

53. **Euphorbia fusiformis** Buch.-Ham. (*Euphorbia acaulis* Roxb.)

A few plants, in leaf, seen in the undergrowth of bamboo forest along river bank near Sunda on 22.xii.63.

54. **Euphorbia bombaiensis** Santapau (*Euphorbia microphylla* Heyne ex Roth, non Lamk.)

Common in cultivated fields. Dangs : *Asrana* 5423.

*55. **Euphorbia perbracteata** Gage.

Very abundant in cultivated fields mixed with *Chrozophora* sp. ; bracts perfoliate ; glands of involucre without petaloid limb ; gland half-moon shaped but serrate or fimbriate ; whole plant pale yellowish green. For the correct identity of the plant see Santapau in *Bull. bot. Soc. Beng.*, 1954, **8** (1) ; 23. Unai : *Santapau* : 18160-18164.

*56. **Euphorbia prostrata** Ait.

Common in cultivated fields. Subir : *Asrana* 2903.

URTICACEAE

57. **Girardinia zeylanica** Decne.

Occasional in dry beds of rivers and streamlets in the forests at Ahwa. Noted on 20.xii.63.

HYDROCHARITACEAE

58. **Ottelia alismoides** Pers.

Fairly common in ditches. Flowers white. Ahwa : *Shah* 10681A.

MUSACEAE

59. **Ensete superbum** (Roxb.) Cheesman (*Musa superba* Roxb.)

This is the wild banana ; common in rock crevices on hill slopes along river banks near Sunda.

CYPERACEAE

60. **Cyperus difformis** Linn.

Occasional in cultivated fields. Ahwa : *Shah* 10756.

61. **Scirpus supinus** Linn.

Occasional in cultivated fields. Ahwa : *Shah* 10745.

GRAMINEAE

62. **Arthraxon lancifolius** (Trin.) Hochst. (*Arthraxon microphyllus* Hochst.)

Waghai : *Asrana* 3043.

63. **Arundinella metzii** Hochst.

Dangs : *Asrana* 5448.

*64. **Capillipedium huegelii** (Hack.) Stapf

A large clump seen in the forest undergrowth. Ahwa-Pimpri Road : *Asrana* 3088.

65. **Arundinella pumila** (Hochst.) Steud. (*Arundinella tenella* Nees ex Steud.)

Common, gregarious, in drying pools by the roadsides. Waghai : *Santapau* 19980-1; Pimpri : *Asrana* 3088.

*66. **Chrysopogon polyphyllus** (Hack.) Blatter & McCann

Occasional along river banks. A very striking plant because of the golden yellow spikelets. Pimpri : *Santapau* 20123 ; Sunda : *Shah* 10714, 10731.

*67. **Cymbopogon martinii** (Roxb.) Wats.

Frequently found in waste places. Subir : *Asrana* 3185.

68. **Echinochloa colonum** (Linn.) Link (*Panicum colonum* Linn.)

Common in moist places. Pimpri : *Asrana* 2777.

*69. **Echinochloa crusgalli** (Linn.) P. Beauv.

Common in moist places. Pimpri : *Asrana* 2779.

60. **Echinochloa frumentacea** Link (*Panicum stagninum* var. *frumentaceum* Cooke)

Cultivated, said to yield inferior sort of grain ; locally known as *basti.* Along Nasik Road : *Santapau* 19240-1, 19519.

71. **Eragrostis diarrhena** (Schult.) Steud. (*Eragrostis interrupta* auct. non Beauv. var. *koenigii* Stapf)

Common in stony places in river beds and in cultivated fields. Unai : *Santapau* 17006 ; Waghai : *Asrana* 3328 ; Dangs : *Asrana* 5459.

72. **Eragrostis japonica** (Thunb.) Trin.

Common, occasionally in dense clumps, in moist places in river beds and cultivated fields. Unai: *Santapau* 20196; Ahwa: *Shah* 10746, 10757-58; Subir: *Asrana* 3174.

*73. **Eragrostis pilosa** (Linn.) P. Beauv.

In small clumps on river beds; rare. Pimpri: *Santapau* 20136.

74. **Eragrostis tenella** (Linn.) P. Beauv. [*Eragrostis tenella* var. *plumosa* (Retz.) Stapf]

Common. Pimpri: *Asrana* 3089.

75. **Melanocenchris jacquemontii** J. & S. (*Gracilea royleana* Hook. f.)

Erect grass in small tufts; common on flat rocks. Ahwa: *Asrana* 2812; Pimpri: *Asrana* 2843.

76. **Hackelochloa granularis** (Linn. f.) O. Kuntze (*Manisuris granularis* Linn.)

Pimpri: *Asrana* 2778.

77. **Ischaemum diplopogon** Hook. f.

Common on rocks on hilly slopes. Waghai: *Santapau* 19688; Ahwa: *Asrana* 3552.

78. **Ischaemum goebelii** Hack. (*Ischaemum aristatum* auct. non Linn.)

Found along railway lines. Waghai: *Fernandez* 2213.

79. **Ischaemum rugosum** Salisb.

Rare in the undergrowth. Along Nasik Road: *Santapau* 20063.

80. **Oplismenus burmannii** P. Beauv.

Waghai: *Asrana* 3042.

81. **Oplismenus compositus** (Linn.) P. Beauv.

Occasional in shade along paths in the forest. Kasarbari: *Shah* 10695; Badripada: *Asrana*: 3268.

82. **Panicum miliare** Lamk.

An escape from cultivation. Along Nasik Road: *Santapau* 20107.

83. **Panicum montanum** Roxb.

Rare, in shade along paths in the forest Along Nasik Road: *Santapau* 20060; Ahwa: *Shah* 10628.

84. **Panicum psilopodium** Trin.

Rare. Unai: *Santapau* 17146.

85. **Setaria glauca** (Linn.) P. Beauv.

Dangs : *Mehendale* 44 ; Pimpri : *Asrana* 2756.

86. **Setaria italica** (Linn.) P. Beauv.

This is said to be cultivated at Waghai ; but only a few plants seen in fields of *Eleusine*.

*87. **Sorghum controversum** (Steud.) Snowden

2-3 m. tall, gregarious near water in shaded places. Unai : *Santapau* 17099.

88. **Sorghum halepense** (Linn.) Pers.

2 m. tall, in fields near river, not in clumps. Waghai : *Santapau* 19613 ; Subir : *Asrana* 3508.

*89. **Sorghum miliaceum** (Roxb.) Snowden var. **miliaceum**

Subir-Ahwa Road : *Asrana* 2841, 3209.

*90. **Themeda quadrivalvis** (Linn.) O. Kuntze var. **quadrivalvis**

In dense clumps in open parts of the forest ; generally 1-1·50 m. tall, sometimes 2-2·50 m. tall. Sunda : *Shah* 10738 ; Kasarbari : *Shah* 10691.

*91. **Themeda triandra** Forsk.

Abundant on the edges of the cultivated fields. Unai : *Santapau* 16952, 17366-7.

ACKNOWLEDGEMENT

The authors are deeply thankful to Dr. N. L. Bor, Royal Botanic Gardens, Kew, for the identification of grasses.

On the Marine Fauna of the Gulf of Kutch

PART III—PELECYPODS (*Continued*)

BY

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(*With* 13 *plates*)

[*Continued from Vol.* **62** (1) : 103]

Family VENERIDAE (*Continued*)

Genus **Paphia** (Bolten) Röding

Shell oval, smooth, and has either deep or shallow concentric markings. Pallial sinus deep and the hinge margin is thin and short and the lunule long. These are also called 'tapestry shells' as some of them (e.g. *Paphia textile*) have beautiful coloured patterns on the shells.

52. **Paphia textile** (Gmelin). Plate XVI, figs. 53a, 53b

Except the region near the umbo, there are strong concentric grooves all over the surface of the shell. There are also characteristic rust-brown V-shaped markings upon the surface (giving it a tapestry-like appearance). The lunule extends to nearly half of the hinge. Inside is glossy and the region near the umbo has a slight orange hue which does not usually extend beyond the pallial line. The pallial sinus is deep and broadly U-shaped.

Pirotan Island.

53. **Paphia malabarica** (Chemnitz). Plate XVI, figs. 54a, 54b

A white comparatively short and light shell internally moderately glossy and externally chalky-white with close, fine concentric striations. The pallial sinus is deep and like an open 'V'.

In the Gulf of Kutch dead shells of this species are washed ashore in large quantities.

Pirotan Island.

54. **Paphia alapapiliones** Röding. Plate XVI, figs. 55a, 55b

Shell glossy, nearly twice as long as high and has a pale brown colour. On the outside there are flattened concentric lines which become almost imperceptible at the anterior and the posterior ends. The margin in front of the umbo is slightly upturned and the umbo is more towards the middle than in the two preceding species. The impressions of the adductors are deep and the pallial sinus is narrow and long.

Veraval.

Genus **Pitar** E. Romer

Shell ovate or like an isosceles triangle, with or without concentric striations upon the surface, and the three cardinal teeth converge beneath the umbo. The second and the third cardinals are cleft in the middle.

55. **Pitar erycina** (Linné). Plate XVII, figs. 56a, 56b

Shell strong, moderately inflated with distinct concentric ridges all over the surface ; outer surface light-brown with dark-brown bands (4 to 5), radiating from the umbo towards the periphery. In fresh specimens there are fine, brown zigzag markings rendering a tapestry shading ; inside smooth, faint orange towards the umbo and white towards the periphery; pallial sinus wide and deep. There is a slight (but definite) waviness in the postero-ventral side, which creates a small concavity on the peripheral line and a corresponding undulation in the circular ridges. Owing to this, there appears to be a shallow keel running from the umbo to the postero-ventral margin. In some shells this concavity and hence the keel are less pronounced than in others.

Veraval. Pirotan Island.

56. **Pitar nobilis** (Reeve). Plate XVII, figs. 57a, 57b

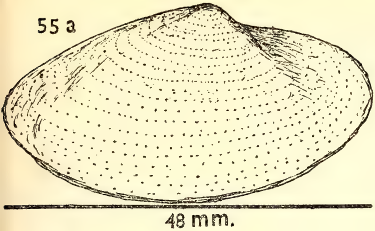
Shell longer than that of *P. erycina*, white, and the posterior concavity (and the resultant keel) of the rim less pronounced. The concentric rings upon the surface, although distinct, are somewhat flattened. We have two rather worn out shells in the collection.

Pirotan Island.

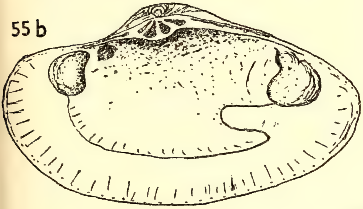
Genus **Circe** Schumacher

Although Thiele (1935) synonymized the genus under *Gafrarium*, both Gravely (1941) and Satyamurti (1956) have given it an independent status. I have followed them. Flattened, nearly circular shells with close concentric sculpture. The pallial sinus is very small. The cardinal teeth are low and the hinge very thick.

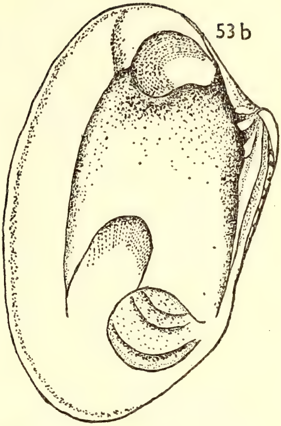
55 a



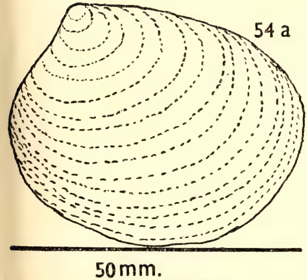
55 b

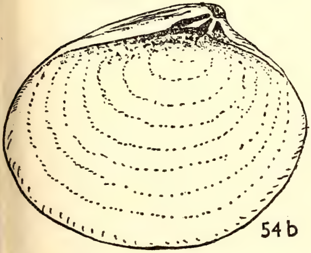


53 b



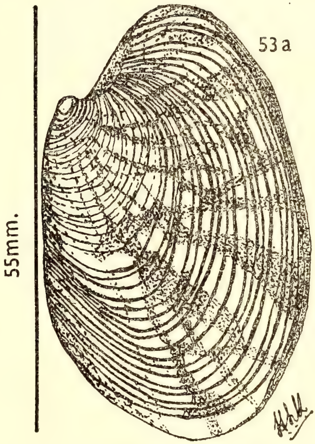
54 a





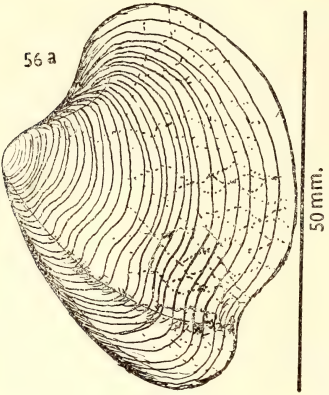
54 b

53 a

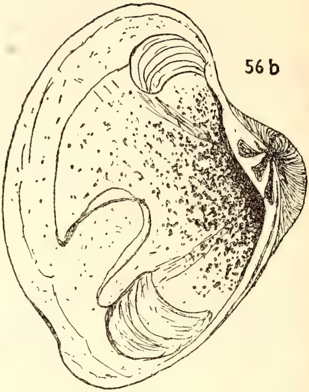


Figs. 53a, 53b. *Paphia textile* : outer and inner views respectively ;
Figs. 54a, 54b. *Paphia malabarica* : outer and inner views respectively ;
Figs. 55a, 55b. *Paphia alapapiliones* : outer and inner views respectively

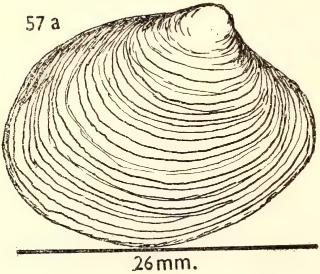
56 a



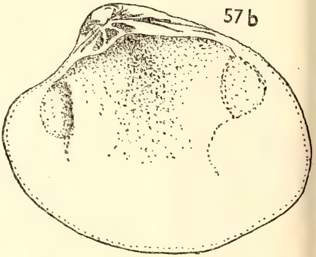
56 b



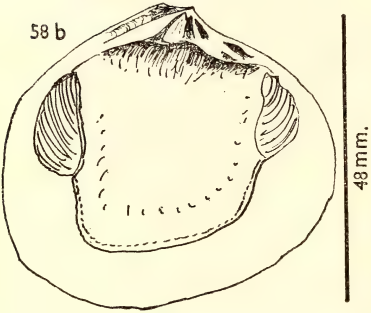
57 a



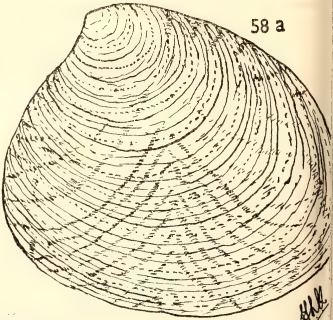
57 b



58 b



58 a



Figs. 56a, 56b. *Pitar erycina* : outer and inner views respectively ;
Figs. 57a, 57b. *Pitar nobilis* : outer and inner views respectively ;
Figs. 58a, 58b. *Circe scripta* : outer and inner views respectively

57. **Circe scripta** (Linné). Plate XVII, figs. 58a, 58b

Shell very flat, fairly heavy with the hind margin somewhat truncated. Some of the fine circular ridges tend to coalesce in the rear. There are also fine divaricating zigzag brown markings upon the surface. Adductor impressions are pronounced and their outer sides are somewhat raised. Pallial sinus is slight and the area along with the pallial line is pinkish, the rest faint yellow.

Gulf of Kutch (the exact locality was not recorded).

Genus **Venus** Linné

Heavy, ovate shells with mostly well-pronounced concentric as well as radial sculpture, three well-formed cardinal teeth, distinct and heart-shaped lunule and crenate inner rim.

58. **Venus chemnitzii** Hanley. Plate XVIII, figs. 59a, 59b

Venus chemnitzii can be easily confused with *Periglypta fischeri* (Récluz), but the pallial sinus in *P. fischeri* is markedly truncate and in this species it is like a moderate 'V'. Both the concentric rings and the radial rays are well developed, the concentric rings in the form of thin lamellae, and the radial rays in the form of thin and very close ridges which cross the concentric lamellae in a manner that gives the latter a corrugated appearance. In the area behind the umbo the lamellae are so closely adpressed that the radial ridges cannot be traced. The radial ridges are more numerous than the concentric lamellae. In this specimen there are about 70 lamellae and 90 to 100 ridges. The lamellae are so thin that they easily break off. The outside is dull white but streaked with occasional brown radial patches. The inside and the cardinal teeth are white. The pallial sinus is angular.

Pirotan Island.

59. **Venus reticulata** Linné. Plate XIX, figs. 60a, 60b

A dull-white heavy and large shell which can be easily recognized by its orange-coloured hinge teeth. The outside presents a reticulate sculpture owing to the presence of thick concentric lamellae and somewhat weaker radial lines. As a result of their decussations the surface presents a tuberculate appearance. Moreover the radial lines, especially in the rear, are somewhat wavy. The pallial sinus is like a broad U.

Pirotan Island.

Genus **Sunetta** Link

The shell has a nearly oval shape, polished internal surface, finely toothed rim, and a depressed ligamentary area. The lunule is also somewhat depressed.

60. **Sunetta scripta** (Linné). Plate XIX, figs. 61a, 61b

Shell smooth but has flattened and somewhat faint concentric lines. There are also brown chevron-shaped colour-patterns upon the surface. The intensity of these patterns varies from place to place. *Sunetta scripta* from Puri (Bay of Bengal) has a deep and impressive colour-pattern which extends right up to the umbo, but in *Sunetta scripta* from Gulf of Kutch the pattern is considerably mild and the umbo is practically white. There is a characteristic wedge-shaped concave area behind the umbo. The inside of the shell is white, glossy with moderately deep pallial sinus and crenulated rim.

Pirotan Island. Hanuman Dandi.

Genus **Gafrarium** (Bolten) Röding

The pallial sinus, if sinuate, is only slightly so. The shell is thick and solid with concentric radial sculpturings. Lunule flat and distinct. The rim of the inside is either finely crenulated or coarsely denticulated.

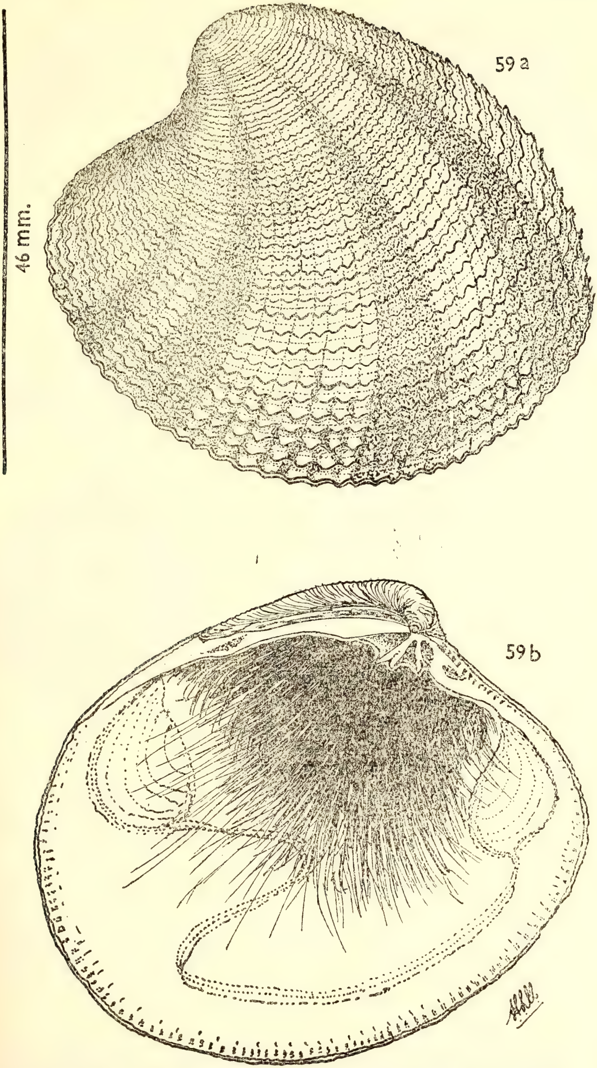
61. **Gafrarium divaricata** (Chemnitz). Plate XIX, figs. 62a, 62b

A roundish and somewhat flattened shell whose outer surface is beautifully sculptured with big concentric and divaricating radial ridges. The concentric ridges tend to fade out posteriorly and anteriorly. Furthermore, there are characteristic reddish brown zigzag markings upon the surface. The inside presents a glossy surface with a slight pallial sinus and a faintly crenate rim.

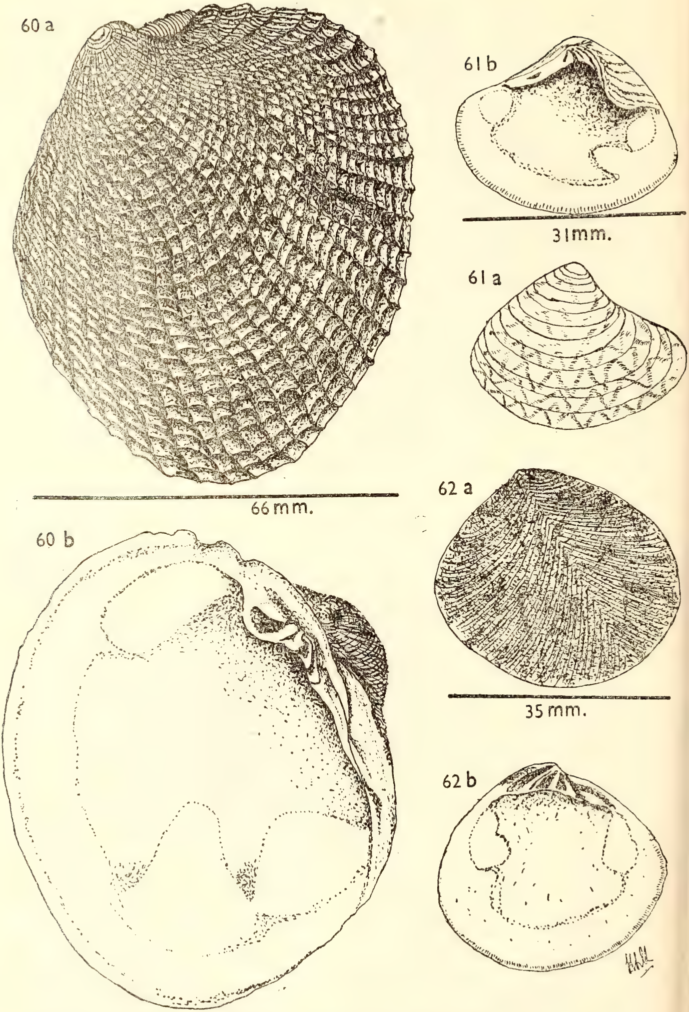
Hanuman Dandi.

62. **Gafrarium tumidum** Röding. Plate XX, figs. 63a, 63b

A very heavy, roundishly oval shell with prominent radial and concentric ridges. In relation to the length and height, this is the heaviest shell in our collection from the Gulf of Kutch. Shell greenish white; radial ribs wide and strong and present a nodular appearance owing to the crossing of the concentric rings; towards the rim the radial ribs tend to bifurcate. A single radial rib sends out secondary radial ribs covering the posterior ¼th of the shell. The inside is chalky white with somewhat depressed and glossy adductor scars, very faint pallial sinus, and coarsely denticulated rim. These denticulations are absent from


46 mm.
59 a
59 b

Figs. 59a, 59b. *Venus chemnitzii*: outer and inner views respectively


60 a
61 b
31mm.
61 a
66mm.
62 a
60 b
35mm.
62 b

Figs. 60a, 60b. *Venus reticulata* : outer and inner views respectively ;
Figs. 61a, 61b. *Sunetta scripta* : outer and inner views respectively ;
Figs. 62a, 62b. *Gafrarium divaricata* : outer and inner views respectively

the posterior ¼th of the rim. There is a shallow keel in the middle of the inside and also a dark-brown mark in the postero-ventral corner.

These shells attain a much larger dimension (than the one described here), becoming relatively more thick (as well as elongated), and the posterior dark patch tends to spread upwards.

Pirotan Island.

Genus **Dosinia** Scopoli

Shell round, flattened with fine concentric ridges and a deep V-shaped pallial sinus, wide hinge, beak-like umbo, and sunk ligament.

63. **Dosinia puella** Angas. Plate XX, figs. 64a, 64b

Shell dull white with fine brown V-shaped markings, with a characteristic angulation about the middle of the posterior margin and somewhat coarse concentric rings (only in comparison with the shells of other families); lunule dark brown, small but distinct, depressed and heart-shaped; line of the rim above the angulation nearly straight.

Hanuman Dandi.

64. **Dosinia cretacea** (Reeve). Plate XX, figs. 65a, 65b

Shell thick with alternate concentric shades of blue and white. There is an angulation at about the middle of the posterior rim, and the line above the rim towards the umbo is more or less arched. The hinge is very thick and the angle formed by the posterior cardinal teeth and the lunule is nearly a right angle.

Hanuman Dandi.

Genus **Tapes** Megerle von Muhlfeld

Shell elongate with hind margins broad and somewhat truncate, and the dorsal margin behind the umbo nearly a straight line. Only one species was found.

65. **Tapes radiatus** (Chemnitz). Plate XX, figs. 66a, 66b

Shell elongate with fine radial grooves and ridges; a few (here 5) strong concentric lines of growth present; pallial sinus very large, U-shaped and nearly horizontal. Only one complete specimen.

Veraval.

Genus **Venerupis** Lamarck

These shells are characterized by the presence of concentric widely spaced and crested laminae. The umbo is situated near the anterior end.

66. **Venerupis macrophylla** Deshayes. Plate XXI, figs. 67a, 67b

A white somewhat rectangular shell with the posterior edge truncated and the umbo directed forwards. A keel runs from the umbo to the postero-ventral corner of the rim. There are a few delicate concentric foliaceous lamellae, whose free margins, towards the postero-ventral end, look somewhat crumpled. In between these lamellae, there are very fine and minute radial lines. The inner surface is smooth and there is a large V-shaped pallial sinus. These live mostly in crevices amongst oysters as a result of which their shape varies a lot.

Veraval.

Family MESODESMATIDAE

Shell heavy, ovately triangular with the anterior side more pointed than the posterior.

Genus **Mesodesma** Deshayes

Shell stout, slightly inequilateral with a thick hinge and strong cardinal and elongated lateral teeth.

67. **Mesodesma glabratum** (Lamarck). Plate XXI, figs. 68a, 68b

Hornell (1951) has described this species as *Atactodea glabrata* Gmelin. The shell which has a somewhat flattened fulvous outside is characterized by fairly strong and regular concentric rings. There is also a thin dark-yellow pellicle (periostracum ?) which envelops the shell. The inside is glossy and the pallial sinus small. The pallial sinus and the adductor impression together present a bi-cuspid appearance. One point deserves special attention. The pallial sinus is situated in the side towards which the umbo is directed.

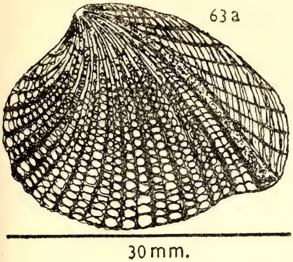
Pirotan Island.

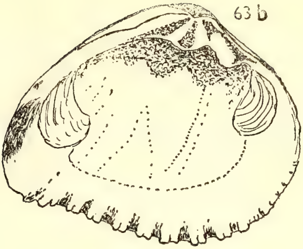
Family MACTRIDAE (False Clams)

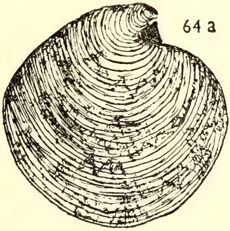
Shell mostly light and nearly triangularly ovate (except *Lutraria*). There is a prominent hinge-pit, thin and elongated lateral teeth, and in the left valve only one cardinal tooth.

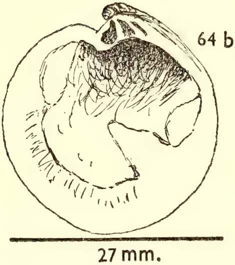
Genus **Mactra** Linné

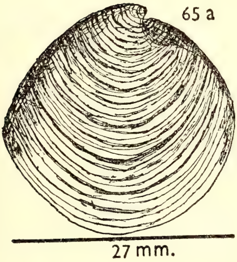
Shell triangular, the cardinal teeth bifid, ligament well developed, and pallial sinus semi-lunar.

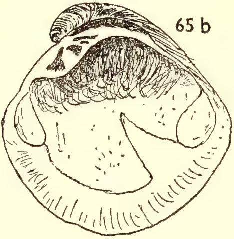

63 a

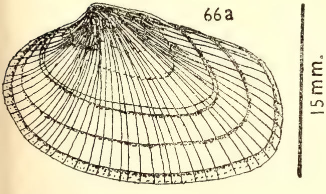

63 b

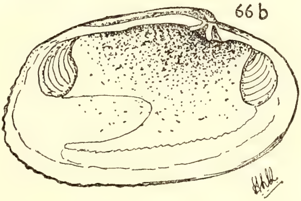

64 a


64 b


65 a

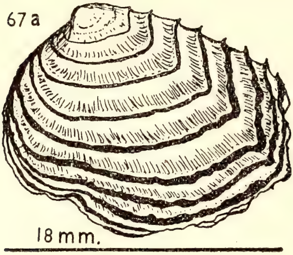

65 b


66 a

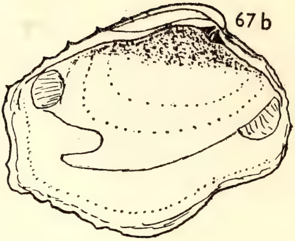

66 b

Figs. 63a, 63b. *Gafrarium tumidum* : outer and inner views respectively ;
Figs. 64a, 64b. *Dosinia puella* : outer and inner views respectively ;
Figs. 65a, 65b. *Dosinia cretacea* : outer and inner views respectively ;
Figs. 66a, 66b. *Tapes radiatus* : outer and inner views respectively

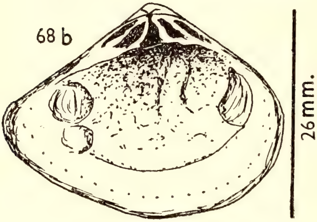
67 a



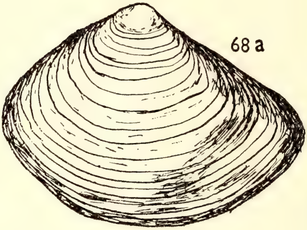
67 b



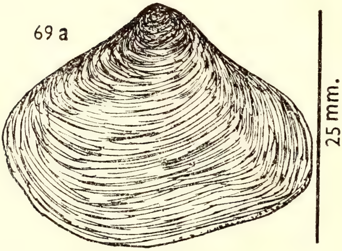
68 b



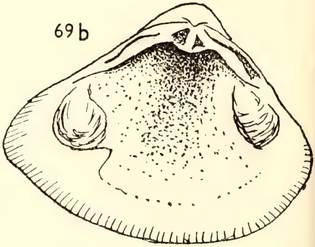
68 a



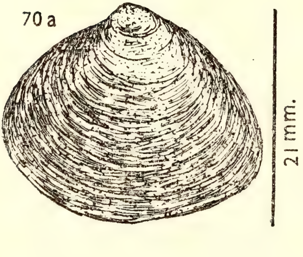
69 a



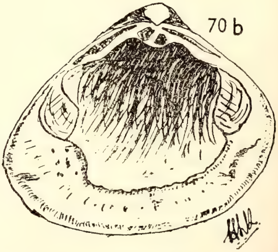
69 b



70 a



70 b



Figs. 67a, 67b. *Venerupis macrophylla* : outer and inner views respectively ;
Figs. 68a, 68b. *Mesodesma glabratum* : outer and inner views respectively ;
Figs. 69a, 69b. *Mactra gibbosula* : outer and inner views respectively ;
Figs. 70a, 70b. *Mactra cuneata* : outer and inner views respectively

68. **Mactra gibbosula** Deshayes. Plate XXI, figs. 69a, 69b

Shell light, gibbous, triangularly cordate, inequilateral and has fine hair-like concentric markings all over the surface save the umbo ; inside smooth and light violet; umbo violet but gradually fades into dull white towards the periphery. The anterior side is short while the posterior side is long.

Veraval.

69. **Mactra cuneata** Chemnitz. Plate XXI, figs. 70a, 70b

Shell small, triangular, well inflated and almost equilateral. The inside is violet, but externally the umbo is bluish violet and the rest faint bluish white. Concentric marks are very thin and indistinct.

Veraval.

Genus **Spisula** Gray

These are triangular shells with nearly equal antero-dorsal and postero-dorsal sides.

70. **Spisula triangularis** (Lamarck). Plate XXII, figs. 71a, 71b

Shell white with smooth but definite concentric markings upon its surface. The inside is smooth and glossy. The adductor impressions are sunk. In general appearance the shell looks like a wide bilateral triangle with an obtuse apical angle.

Pirotan Island.

Genus **Standella** Gray

The valves are inequivalves, white, thin, radially sculptured and gape in front and behind. The pallial sinus is very large.

71. **Standella nicobarica** (Gmelin). Plate XXII, figs. 72a, 72b

Shell easily recognized by its pure white colour, lightness, and fine radial ridges all over the surface ; dorsal margin behind the umbo almost straight and the posterior end somewhat truncated. Upon the surface of the hind end the radial ridges are very fine and divaricate from one radial ridge. There are a few shallow growth rings. The pit of the nodule of the ligament is triangular and the cardinal tooth is thin. These shells are washed ashore in large numbers.

Pirotan Island.

72. **Standella pellucida** (Gmelin). Plate XXII, figs. 73a, 73b

An elliptical shell with the umbo placed in the middle of the dorsal line ; pallial sinus narrow but deep. The shell is fairly thin and its outer surface bears fine concentric rings.

Pirotan Island.

Genus **Lutraria** Lamarck

The hind part of the upper margin of the shell and the lower margin are nearly parallel. The pit for the nodule of the ligament is large and conical and the side teeth as well as the grooves for their reception are thin.

73. **Lutraria arcuata** Deshayes. Plate XXII, figs. 74a, 74b

Shell arcuately oblong; the anterior as well as the posterior sides rounded; dorsal rim behind the umbo is slightly concavely arched whereas the rim in front of it is convexly arched. Surface covered with a thin greenish brown horny periostracum and sculptured with fine concentric lines (although somewhat irregular). The inside is glossy white and the pallial sinus is large and deep. According to Reeve (1843-78), this species is found in the Philippine Islands too.

Pirotan Island.

Family DONACIDAE (Wedge Shells)

These shells are triangular and have the anterior sides longer than the posterior. The pallial sinuses are large and rounded.

Genus **Donax** Linné

The shell is flattened. ' Ligament in a groove, its nodule external, mounted on a short ledge.'

74. **Donax cuneatus** Linné. Plate XXIII, figs. 75a, 75b

There is a keel running from the umbo to the posterior ventral corner of the edge. The concentric rings behind this keel are sharp and their rims are granular. The rest of the surface is smoother than this but has fine concentric and still finer radial sculpturings. There are also radial bands of white and purplish brown. The inside is glossy white, punctuated with wide radial purplish brown marks.

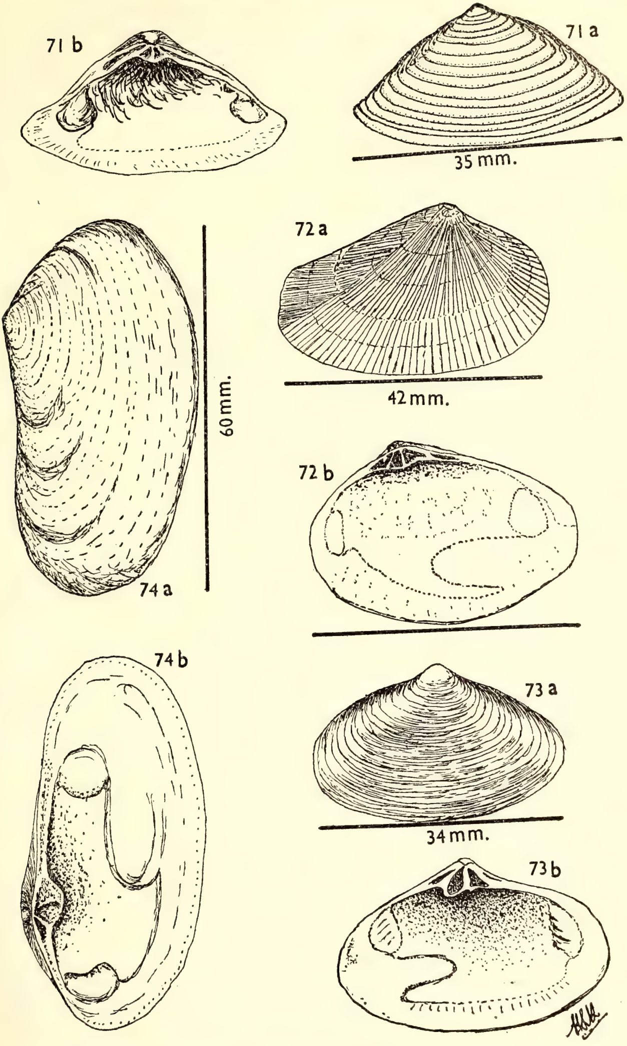
Pirotan Island. Hanuman Dandi.

Family PSAMMOBIIDAE

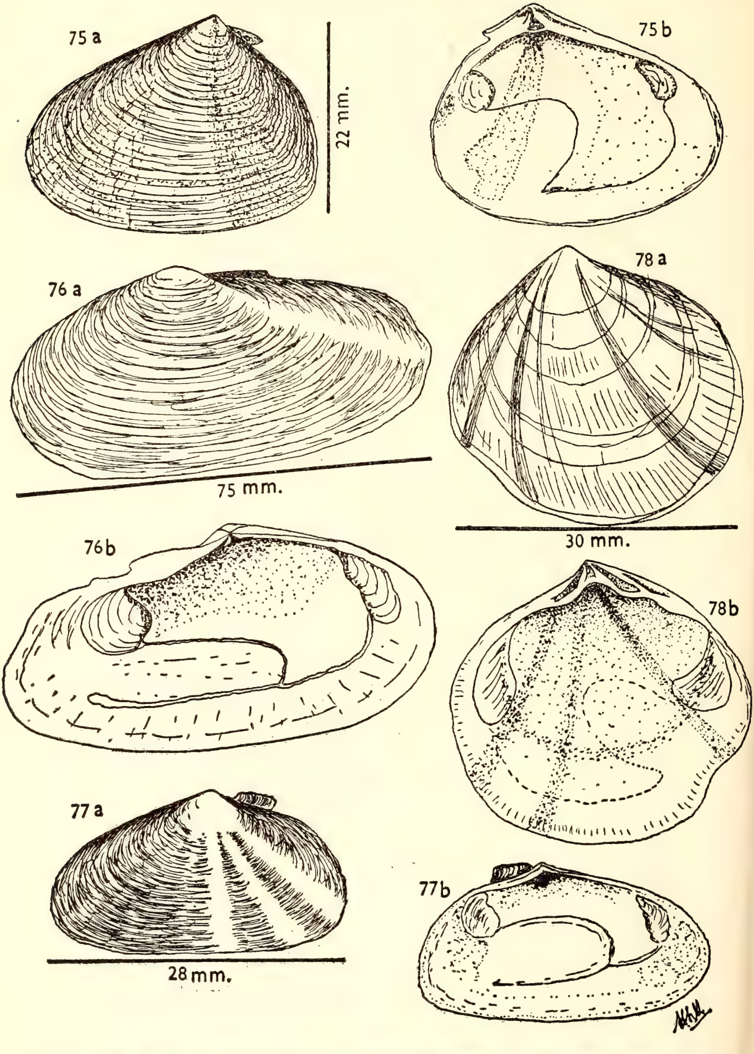
These have an oval or elongate shell with the ligament mounted externally on a thin ledge. There are usually two small cardinal teeth and no laterals. The pallial sinus is large, U-shaped, and its lower limb is confluent with the pallial line.

Genus **Psammobia** Lamarck

These are broadly elongate shells with a somewhat truncate posterior end. Furthermore the posterior end is slightly narrower than the anterior end. The shells are rather thin but hard.


71 b
71 a
35 mm.
72 a
42 mm.
60 mm.
74 a
72 b
74 b
73 a
34 mm.
73 b

Figs. 71a, 71b. *Spisula triangularis*: outer and inner views respectively; Figs. 72a, 72b. *Standella nicobarica*: outer and inner views respectively; Figs. 73a. 73b. *Standella pellucida*: outer and inner views respectively; Figs. 74a, 74b. *Lutraria arcuata*: outer and inner views respectively


75 a
22 mm.
75 b
76 a
75 mm.
78 a
30 mm.
76b
78b
77 a
28 mm.
77b

Figs. 75a, 75b. *Donax cuneatus* : outer and inner views respectively ;
Figs. 76a, 76b. *Psammobia radiata* ; outer and inner views respectively ;
Figs. 77a, 77b. *Soletellina diphos* : outer and inner views respectively ;
Figs. 78a, 78b. *Semele crenulata* : outer and inner views respectively

75. **Psammobia radiata** Philippi. Plate XXIII, figs. 76a, 76b

A large faint-pink translucent shell with fine concentric striations and an indistinct keel running from the umbo to the lower hind angle. The adductor impressions are deep and the area bound by the pallial line is thicker than the rest.

Hanuman Dandi.

Genus **Soletellina** Blainville

These are thin shells of dark hue. Many of them have one or more whitish streaks radiating from the umbo. Although according to Gravely (1941) these shells are usually large, the shells in our collection are all very small and thin.

76. **Soletellina diphos** Reeve. Plate XXIII, figs. 77a, 77b

A thin, glossy dark-brown shell (of horny consistency) with very faint concentric striations and the hind end somewhat truncated. There are two characteristic whitish streaks running from the umbo to the rear of the horizontal ventral margin. The pallial sinus is very large, and throughout its ventral side it is merged with the pallial line below. Crichton (1941) has placed this shell in the family Garidae. However I have followed Gravely (1941).

Pirotan Island.

Family SEMELIDAE

Shells mostly circular and rather flattened and the ligament, instead of being mounted on a projecting ledge (e.g. Donacidae, Psammobiidae), is situated internally within a dagger-shaped groove behind the cardinal teeth. The cardinal teeth are either one or two and are usually shallow.

Genus **Semele** Schumacher

The shell is almost round (in lateral view) with fine concentric and radial ridges upon the external surface. There are two cardinal teeth (and often a lateral tooth) and a large pallial sinus.

77. **Semele crenulata** (Sowerby). Plate XXIII, figs. 78a, 78b

The almost round valve has equally pronounced radial and circular markings. The markings are somewhat faded on the posterior side and in the vicinity of the umbo. In fresh specimens one can see beautiful pink rays fanning out from the umbo, resembling in shape the figure of *Semele sinensis* A. Adams as given by Gravely (1941).

Pirotan Island.

78. **Semele striata** (Rüppell). Plate XXIV, figs. 79a, 79b

This shell differs from the previous species in being thicker and in the absence of radial lines. Moreover it is somewhat squarish.

Pirotan Island.

Family TELLINIDAE (Paper Shells)

These are thin shells with large pallial sinus and usually a beaked hind margin. The ligament is situated externally. Furthermore, in addition to the cardinals, the right valve bears lateral teeth.

Genus **Tellina** Linné

The front margin is roundish. The pallial sinus is extensive. The valves are characterized by a single cardinal tooth in the left but two in the right, in addition to which there may be lateral teeth.

79. **Tellina coarctata** Philippi. Plate XXIV, figs. 80a, 80b

A large inflated white shell with fairly thin but strong valves. The surface has fine hair-like circular ridges and is characterized by the presence of a strong keel running from the umbo to the lower hind angle. There are also two shallow keels which follow it and one concave keel that precedes it. The umbo is placed posteriorly. The pallial sinus is large and rectangular. However, it does not extend beyond ⅔rd of the distance between the posterior and the adductor scars.

Pirotan Island.

80. **Tellina pristis** Lamarck. Plate XXIV, figs. 81a, 81b

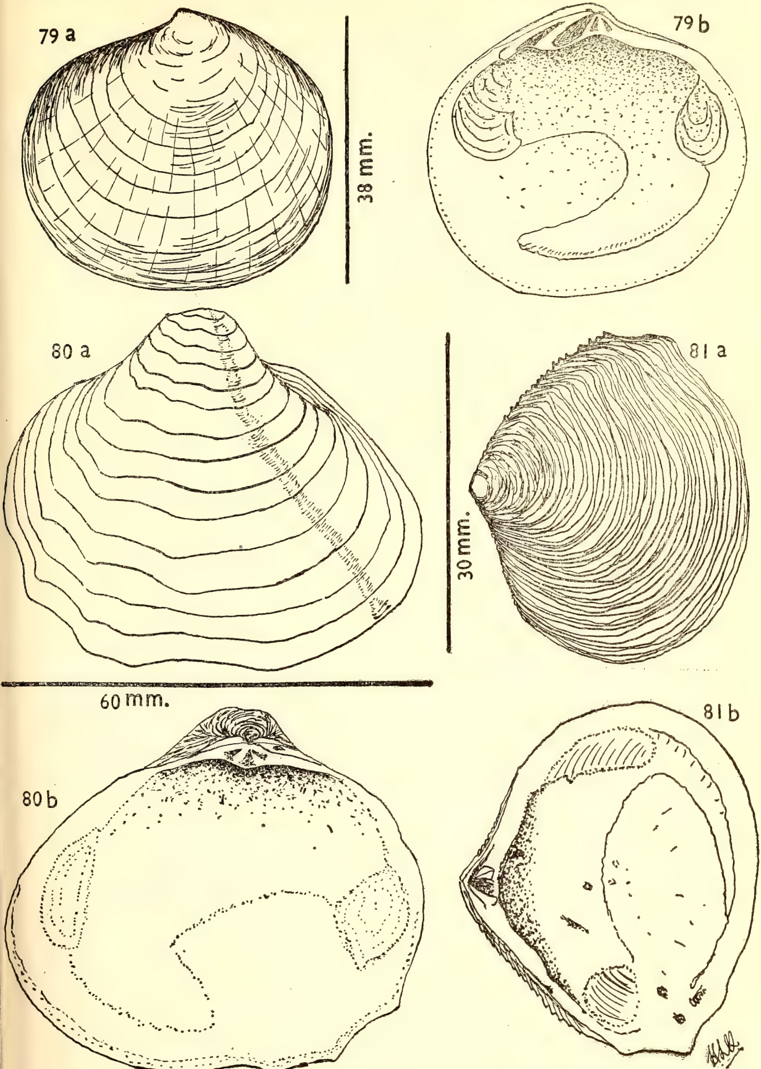
A triangular, flattened and somewhat heavy shell with strong concentric ridges. The hind margin is nearly straight and always toothed. This toothed nature of the hind margin makes it easy to recognize the shell. The pallial sinus is very large and almost reaches the anterior adductor scar. The shell is white.

Pirotan Island.

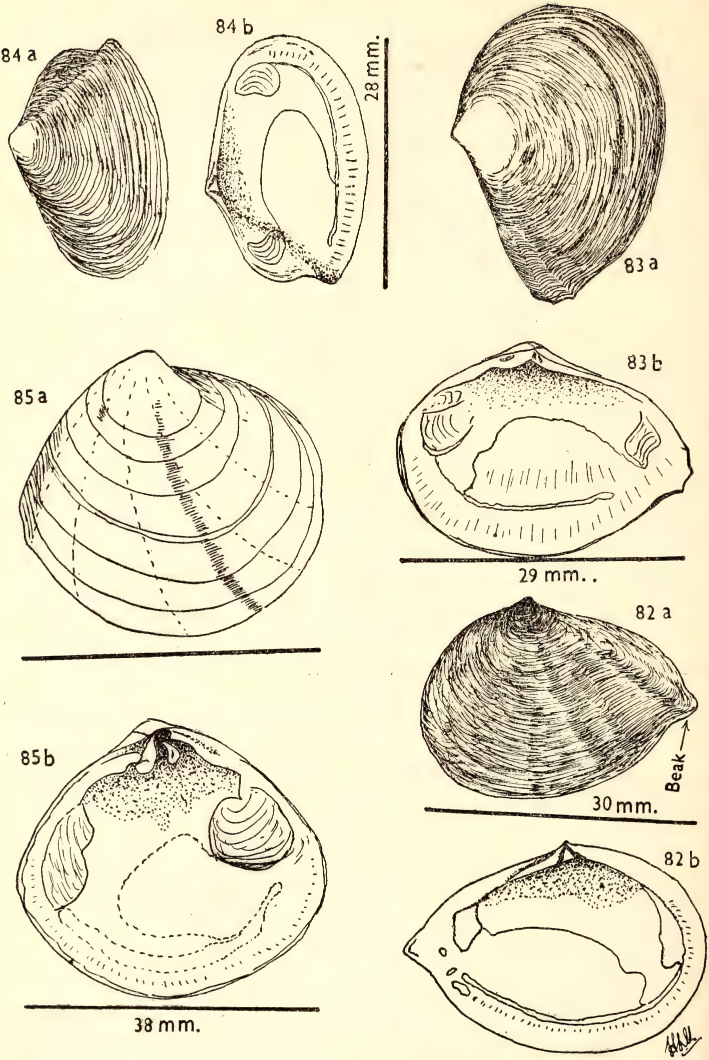
81. **Tellina ala** Hanley. Plate XXV, figs. 82a, 82b; figs. 83a, 83b

A thin, flattened, and elliptical shell having the surface covered with extremely fine concentric markings; hind margin notched into a definite beak, rest of the margin evenly rounded and smooth. There is hardly any keel. The pallial sinus is very large and reaches nearly the anterior adductor scar. There is at least one small scar near the ventral hind angle, outside the pallial line.

Tellina ala appears to be a rather variable species. We have in our collection another specimen of *T. ala* from the same locality which has a definite keel extending from the beak to the umbo. Moreover this


79 a
38 mm.
79 b
80 a
81 a
30 mm.
60 mm.
81 b
80 b

Figs. 79a, 79b. *Semele striata* : outer and inner views respectively ;
Figs. 80a, 80b. *Tellina coarctata* : outer and inner views respectively ;
Figs. 81a, 81b. *Tellina pristis* : outer and inner views respectively


84 a
84 b
28 mm.
83 a
85 a
83 b
29 mm..
82 a
Beak
30 mm.
85 b
38 mm.
82 b

Figs. 82a, 82b. *Tellina ala* : outer and inner views respectively ;
Figs. 83a, 83b. *Tellina ala* : (another variety) ;
Figs. 84a, 84b. *Tellina emarginata* : outer and inner views respectively ;
Figs. 85a, 85b. *Tellina bruguieri* : outer and inner views respectively

one has a more inflated shell and a smoother surface than the previous one (figs. 83a, 83b).

Pirotan Island (both specimens).

82. **Tellina emarginata** Sowerby. Plate XXV, figs. 84a, 84b

Shell very thin (but hard), parabolic, and has extremely fine concentric markings upon the surface. However, instead of a keel there is a characteristic radial furrow in the posterior side. Hence the posterior rim looks like a ‘ S ’, and has a corresponding internal ridge.

Pirotan Island.

83. **Tellina bruguieri** Hanley. Plate XXV, figs. 85a, 85b

A fairly strong shell almost triangular with large and somewhat bent cardinal tooth and an elongate scar for the anterior adductors. The right valve has a very large cardinal tooth. All over the surface there are very fine hair-like concentric lines.

Pirotan Island.

There are some members of this species which are characterized by the possession of a much thinner shell with extremely fine concentric markings. Plate XXVI, figs. 86a, 86b.

Pirotan Island.

Genus **Gastrana**

These are characterized by the possession of heavy, oval shells having fairly conspicuous and comparatively thick concentric markings (in comparison with members of *Tellina*), which in fresh shells look like concentric lamellae.

84. **Gastrana polygona** (Hanley). Plate XXVI, figs. 87a, 87b.

A heavy shell with strong keels radiating out from the umbo. Two such keels which run towards the hind end are more pronounced than the rest and impart to the hind rim a wavy outline. The anterior rim is round. In fresh shells the outer surface is covered with thin lamellar concentric rings. In old ones these lamellae tend to break off. Inside, near the proximal end of the anterior adductor scar, there is a tooth-like process. The shell is white but when viewed from the inside, the centre of the valve presents a yellowish hue.

Pirotan Island.

Family GLAUCOMYIDAE

These are oval and inflated shells with large V-shaped pallial sinus. According to Hornell (1951) these shells are frequent in brackish water.

Genus **Glaucoma**

Characters same as above.

85. **Glaucomya cerea** Reeve. Plate XXVIII, figs. 94a, 94b

The shell is comparatively thin, dull white in colour, and has fine concentric striations all over the surface. The adductor impressions are narrow and the tips of the cardinal teeth are split.

Pirotan Island.

Family SOLENIDAE (Razor Shells)

The shell is tubular with the umbo usually placed at its anterior end.

Genus **Solen** Linné

The shells are long and cylindrical. Both the front and the hind margins are truncated. There is only one tooth in each valve.

86. **Solen truncatus** Wood. Plate XXVI, figs. 88a, 88b

The upper and the lower margins are parallel to one another. The front margin is vertical but slightly inclined forwards. The hind margin is a little rounded off. There is also a vertical furrow near the rim of the front margin. The tooth is placed close behind the front margin. The pallial line runs somewhat obliquely from the anterior to the posterior end.

Belarpur Bay.

Genus **Cultellus** Schumacher

The shell is fairly thick, moderately elongated but round at both ends. The umbo is placed far behind the anterior end. The cardinal teeth are two.

87. **Cultellus maximus** (Gmelin). Plate XXVI, figs. 89a, 89b

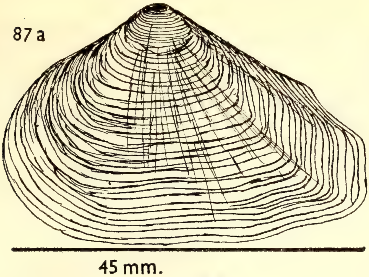
Shell rather small, white and glossy with fine concentric striations on the surface and the posterior end more tapering than the anterior. The anterior adductor scar is triangular while the posterior one is oval. The pallial sinus is very shallow and semi-lunar.

Pirotan Island.

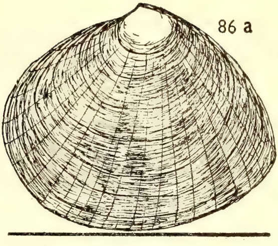
Family GASTROCHAENIDAE

The shell is somewhat elongated or round, and the ligament is external and mounted on a ledge.

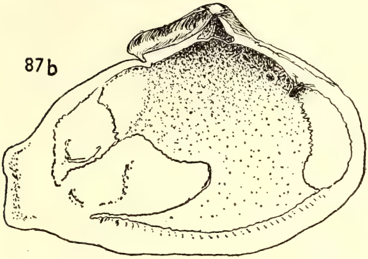
87 a



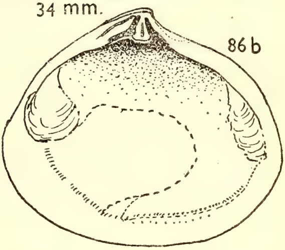
86 a



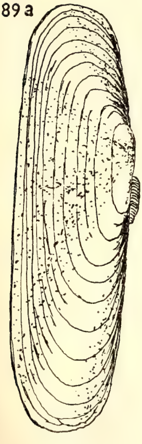
87 b



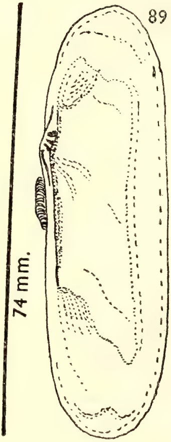
86 b



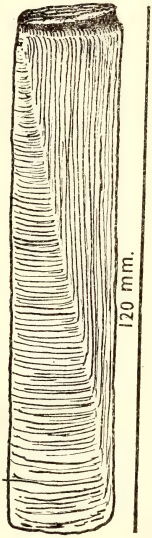
89 a



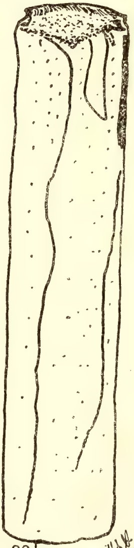
89 b



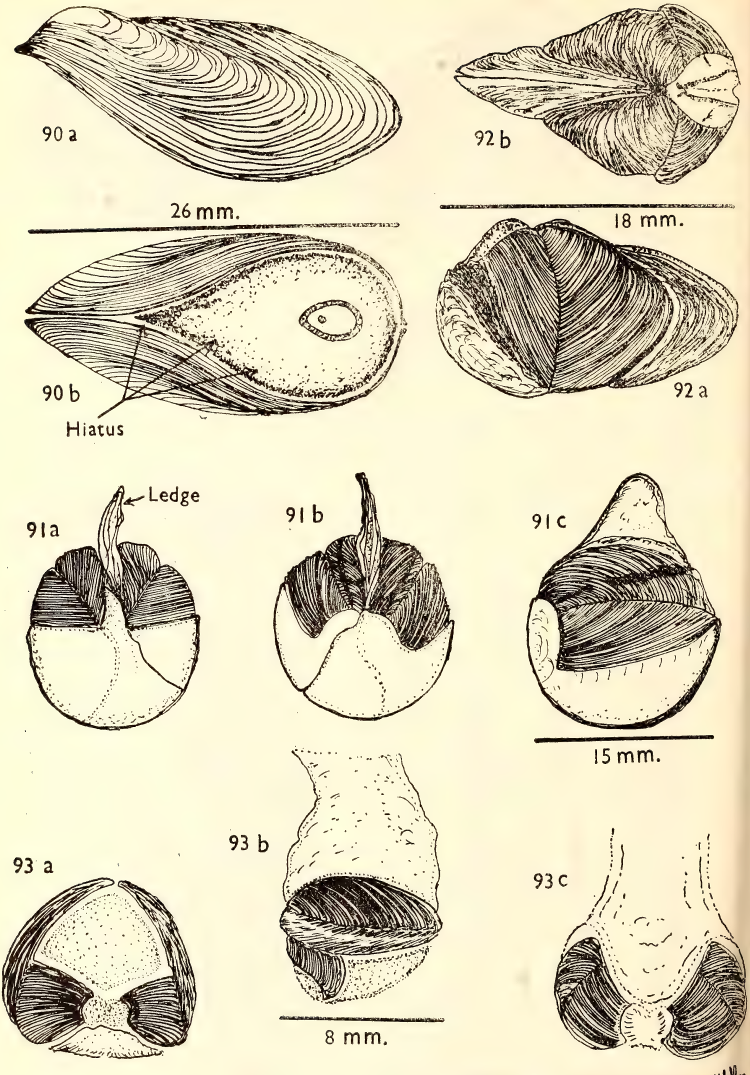
88 a



88 b



Figs. 86a, 86b. *Tellina bruguieri* : (another variety) ;
Figs. 87a, 87b. *Gastrana polygona* : outer and inner views respectively ;
Figs. 88a, 88b. *Solen truncatus* : outer and inner views respectively ;
Figs. 89a, 89b. *Cultellus maximus* : outer and inner views respectively


90 a
92 b
26 mm.
18 mm.
90 b
Hiatus
92 a
91 a
Ledge
91 b
91 c
15 mm.
93 a
93 b
93 c
8 mm.

Figs. 90a, 90b. *Gastrochaena lamellosa*: Entire animal—lateral and ventral views respectively; Figs. 91a-91c. *Jouannetia cumingii*: entire animal—different views; Figs. 92a, 92b. *Martesia striata*: entire animal—lateral and ventral views respectively; Figs. 93a-93c. *Teredo* sp.: proximal end of the animal—different views

Genus **Gastrochaena** Spengler

These are found mostly among coral rocks. The valves are somewhat twisted, the umbo is placed near the anterior end, and the surface has fine concentric sculpture. The siphons are fused into one.

88. **Gastrochaena lamellosa** (Deshayes). Plate XXVII, figs. 90a, 90b

The ventral gape of the entire animal (hiatus) does not reach the hind end. However, the shell is rather inflated and the hiatus is wide. The concentric rings approach lamella-like form towards the hind end.

Pirotan Island.

Family PHOLADIDAE (Piddocks)

These bivalves are borers into wood or coral rock and have white, equi-valved and ribbed (often toothed) shells. The ligament and the hinge margin are absent. The valves are held together by muscles only. In the postero-dorsal portion accessory plates may be present. Part of the anterior end may be folded outwards.

Genus **Jouannetia** Des Moulins

The shells are nearly ball-like and a partition divides each valve into a large anterior and a small posterior half.

89. **Jouannetia cumingii** (Sowerby). Plate XXVII, figs. 91a to 91c

The shell is more or less like a white globule with a tongue-like structure (ledge) protruding from one side. Found among coral rocks.

Pirotan Island. Hanuman Dandi.

Genus **Martesia** (Leach) Blainville

The shell is elongate and has a conical appearance.

90. **Martesia striata** (Linné). Plate XXVII, figs. 92a, 92b

The anterior ledge looks more or less like a duck's beak. Except at the posterior end there are fine striations all over the shell.

Pirotan Island.

Family TEREDINIDAE (Shipworms)

The members of this family usually bore into wood and live within long hard calcareous tubes produced by their own secretion. The major portion of the body consists of a long tube formed by the fusion of the siphons. The distal end of this tube is not fused. Upon the juncture of the separate siphons with the fused body there are a pair of tiny calcareous plates—the pallets. It is said that these pallets protect the animal from the intrusion of undesirable elements into the body tubes. In the proximal end of the body there are two small valves.

Genus **Teredo** Linné

Teredos are characterized by the presence of paddle or spoon-shaped pallets. Sometimes these pallets bear a calcareous knob at their terminal ends.

91. **Teredo** sp. Plates XXVII and XXVIII, figs. 93a to 93h

This specimen, which is preserved in formalin, is nearly 165 mm. long. Its proximal end is somewhat wide (about 12 mm.) and generally tapers off towards the distal end where, just before receiving the pallets and the siphons, the body tube dilates outwards like a flower. There is a calcareous patch upon one side of this dilatation (fig. 93d). Each pallet has again a dark, nearly paddle-shaped distal end and a whitish tubular proximal end (stalk). Inside, each valve has a bent blade-like structure (Plate XXVIII, fig. 93e).

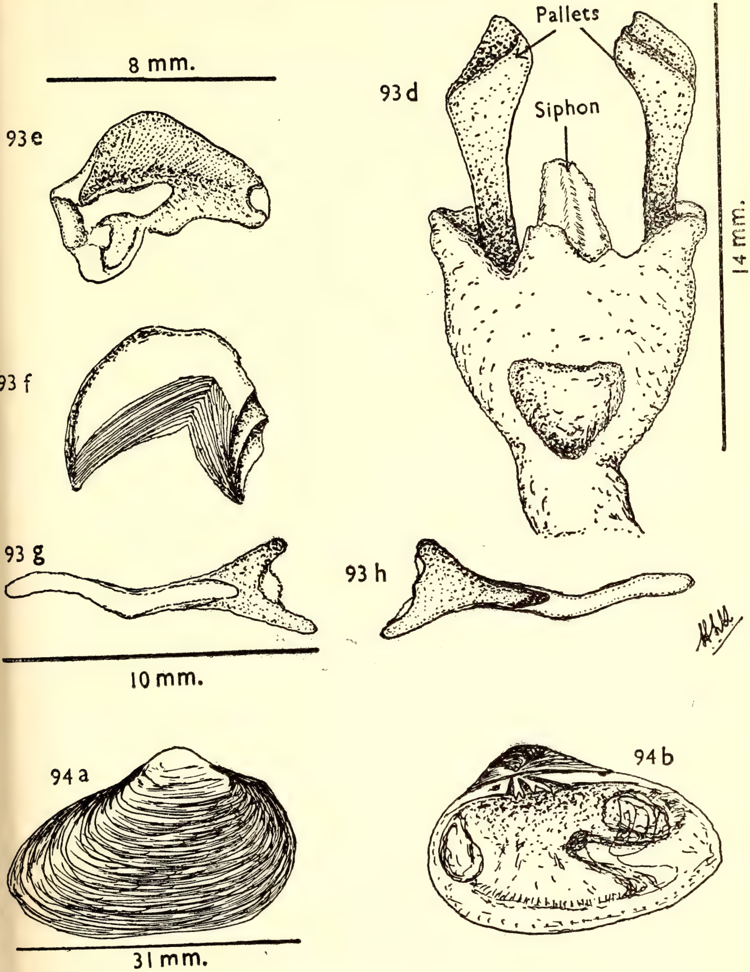
VI. GENERAL DISCUSSION

(a) *Distribution and frequency*

A comparison of the present account with the accounts of pelecypods of Bombay, Karwar, Madras, and Krusadai given respectively by Hornell (1951), Patil (1952), Gravely (1941), and Satyamurti (1956) shows that some species which are absent from one or more of these areas are present in the Gulf of Kutch and vice versa. Also, the relative abundance of the same species may vary from place to place. This has been presented in tabular form (Table IV). Such difference in distribution and abundance may be due to the difference in the habitats. For example, *Pholas bakeri* Desh. (Pholadidae) is abundant in the Bombay area but not found in the Gulf of Kutch. Furthermore, in the accompanying table (Table IV) an attempt has also been made to give an idea about the relative abundance of all the species in the Gulf of Kutch.

(b) *Measurements*

From a survey of the literature a rather high degree of flexibility appeared in the methods of measurement adopted by different workers. Therefore, to avoid confusion, I have clearly defined and illustrated all the measurements I have used in this work (Plate I). I have also recorded the dry weights of single valves of each species (Table V). It is found that the valves of some species although of identical geometrical measurements differ considerably in weight. For example the valves of *Dosinia puella* and *Dosinia cretacea* (Veneridae) have almost the same


Pallets
93d
Siphon
14 mm.
8 mm.
93e
93f
93g
93h
10 mm.
94a
94b
31 mm.

Figs. 93d-93h. *Teredo* sp. (continued from Plate XXVII, fig. 93a): distal end of he animal—various parts. Fig. 93d: distal end; figs. 93e, 93f: the inner and outer iews respectively of one valve; figs. 93g, 93h: both sides of a single pallet. Figs. 94a, 94b. *Glaucomya cerea*: outer and inner views respectively

dimensions. However, the valve of *D. cretacea* is almost twice as heavy as that of *D. puella.* Such findings may not be rare with other species.

(c) *Length : height indices of Lithophagans* (*Mytilidae*)

If we compare the ratios of length to height of these species we find that their indices gradually increase from *Lithophaga cinnamomea* towards *Lithophaga nigra.* This will be evident from Table I.

TABLE I

THE LENGTH : HEIGHT INDICES OF *Lithophaga* (Mytilidae)

Species	Length	Height	Length:Height	Umbo
Lithophaga cinnamomea	23·2 mm.	10·5 mm.	2·21	Ultra-terminal
Lithophaga sp. (near *cinnamomea)*	27·2 mm.	9·8 mm.	2·77	do.
Lithophaga sp. (near *teres)*	26·2 mm.	9·0 mm.	2·91	do.
Lithophaga teres	32·6 mm.	10·0 mm.	3·26	Infra-terminal
Lithophaga nigra	40·0 mm.	10·6 mm.	3·77	do.

Two points emerge. First the length : height ratio gradually increases from *L. cinnamomea* to *L. nigra.* Secondly, those with the ratio *lower than three* have ultra-terminal umbones whereas those with a ratio *above three* have infra-terminal umbones. This shifting of the umbo from an ultra-terminal to an infra-terminal position or vice versa must have been the result of gradual change. Unfortunately there is no specimen in our collection whose umbo is between these two types, i.e. just terminal. But I feel strongly inclined to believe that a more extensive search may lead to the discovery of such an intermediate stage.

(d) *Denticulations in the hinge of* Meretrix (*Veneridae*)

On one lateral tooth and its corresponding groove, all *Meretrix* shells have some fine denticulations. When examined under a microscope, these present extremely fine and varied configurations. Here at least one feature merits special attention. The number of the denticles usually varies directly with the length of the groove (or the tooth). Table II will illustrate this point.

TABLE II

THE RELATIONSHIP BETWEEN THE NUMBER OF DENTICLES AND THE LENGTH OF THE GROOVE BEARING THE DENTICLES UPON THE HINGE OF *Meretrix* (VENERIDAE)

Specimen	Length of the valve	Length of the groove	Number of the denticulations
1	65·0 mm.	15·2 mm.	52
2	63·0 mm.	12·5 mm.	57
3	39·1 mm.	5·8 mm.	35
4	30·8 mm.	5·2 mm.	32
5	30·0 mm.	5·3 mm.	28
6	30·1 mm.	5·1 mm.	26
7	27·8 mm.	3·7 mm.	23

A more thorough study with a large number of shells may lead to the establishment of a correlation between the age of a pelecypod (*Meretrix*) and the number of denticulations in its valve.

(e) *Relation between the shape and the age of the valve*

During the present work it is noticed that some shells change their shape as they grow. *Gafrarium tumidum* (Veneridae) has a roundish valve when young. The valve becomes more elongate with age. This will be apparent from Table III.

TABLE III

MEASUREMENTS OF *G. tumidum* (VENERIDAE) OF DIFFERENT SIZES

Specimen	Length	Height	Depth	Length : Height	Weight
1	52·1 mm.	42·0 mm.	21·3 mm.	1·25	39·995 gm.
2	44·9 mm.	35·5 mm.	14·4 mm.	1·26	14·505 gm.
3	40·0 mm.	33·2 mm.	14·6 mm.	1·20	12·004 gm.
4	37·8 mm.	31·0 mm.	12·7 mm.	1·20	9·779 gm.
5	31·4 mm.	26·8 mm.	10·5 mm.	1·17	5·703. gm.
6	28·0 mm.	23·5 mm.	9·3 mm.	1·19	4·264 gm.
7	21·7 mm.	20·0 mm.	5·8 mm.	1·08	1·597 gm.

Therefore it is felt, in describing a pelecypod shell, its dimensions and weight are very useful.

TABLE IV

DISTRIBUTIONAL FREQUENCY OF THE PELECYPODS OF THE GULF OF KUTCH AND A COMPARISON SHOWING THEIR RELATIVE ABUNDANCE ON OTHER COASTS OF INDIA

(XXO = very abundant; XX = abundant; XO = common; X = occasional; O = rare; P = present; P (?) = the author has mentioned the genus but not the species)

SPECIES	DISTRIBUTIONAL FREQUENCY				
	GULF OF KUTCH	BOMBAY (Hornell 1951)	KARWAR (Patil 1952)	MADRAS (Gravely 1941)	KRUSADAI Is. (Satyamurti 1956)
ARCIDAE					
Arca gubernaculum	XO	—	—	P	P
A. granosa	X	P	P	P	—
A. rhombea	X	P	P	P	—
A. inaequivalvis	X	P	—	P	P
A. tortuosa	XX	—	P	P	P
A. symmetrica	XX	—	—	P	P
A. navicularis	X	—	—	—	—
A. avellana	X	—	—	P (rare)	P
A. fusca	XX	—	—	—	P
A. complanata	X	—	P	P	P
A. bistrigata	XO	P	—	P	—
Barbatia obliquata	X	P	—	—	—
GLYCIMERIDAE					
Glycimeris taylori	XXO	—	—	P	P
MYTILIDAE					
Mytilus viridis	O	P	P	P	P
Modiolus metcalfei	XO	—	—	P	P
Septifer bilocularis	O	—	—	P	P
Lithophaga cinnamomea	O	—	—	—	P
L. sp. (near *cinnamomea*)	O	—	—	—	—
L. sp. (near *teres*)	XO	—	—	—	—
L. teres	XO	—	—	—	P
L. nigra	XO	—	—	—	P
PTERIIDAE					
Pinctada vulgaris	XO	—	—	P	P
PINNIDAE					
Pinna bicolor	XO	—	—	—	P
Pinna atropurpurea	X	—	—	—	P
PECTINIDAE					
Pecten tranquebaricus	X	—	—	P	P
P. distans	X	—	—	—	—
P. crassicostatus	X	—	—	P	P
P. pyxidatus	O	—	—	P	—
Spondylus layardi	X	—	—	P	P
LIMIDAE					
Lima lima	X	—	—	—	P
ANOMIIDAE					
Anomia achaeus	O	P	—	P	—
Placenta placenta	XO	P	—	P	P

TABLE IV—(*Continued*)

SPECIES	DISTRIBUTIONAL FREQUENCY				
	GULF OF KUTCH	BOMBAY (Hornell 1951)	KARWAR (Patil 1952)	MADRAS (Gravely 1941)	KRUSADAI Is. (Satyamurti 1956)
OSTREIDAE					
Ostrea madrasensis ..	X	—	P	P	P
O. folium ..	X	—	—	—	P
CRASSATELLIDAE					
Crassatella rostrata ..	XO	—	P	P	P
CARDITIDAE					
Cardita bicolor ..	XH	—	—	P	P
Beguina variegata ..	X	—	P (?)	P	P
LIBITINIDAE					
Libitina vellicata ..	X	—	—	P	—
LUCINIDAE					
Lucinia edentula ..	XXO	—	—	P	P
Codakia divergens ..	X	—	—	—	P
Divaricella cumingii ..	O	—	—	—	P
CHAMIDAE					
Chama spinosa ..	X	—	—	—	—
C. fragrum ..	X	—	—	—	P
C. reflexa ..	X	—	—	P	P
CARDIIDAE					
Cardium asiaticum ..	X	P	—	P	P
C. assimile ..	XXO	—	—	P	P
C. australe ..	XO	—	—	P	P
C. flavum ..	XO	—	—	—	P
C. setosum ..	XO	—	—	P	P
VENERIDAE					
Meretrix meretrix ..	XO	P	P	—	—
M. casta ..	X	—	—	P	P
Paphia textile ..	XX	P	P (?)	P	P
P. malabarica ..	XXO	—	—	P	P
P. alapapiliones ..	X	—	—	P	P
Pitar erycina ..	XO	—	—	P	P
P. nobilis ..	X	—	—	—	P
Circe scripta ..	XO	—	P (?)	P	P
Venus chemnitzii ..	XO	—	P (?)	—	P
V. reticulata ..	XO	—	P (?)	—	P
Sunetta scripta ..	X	—	P (?)	P	P
Gafrarium divaricata ..	XX	P	—	P	P
G. tumidum ..	XO	—	P (?)	—	P
Dosinia puella ..	XO	—	—	—	P
D. cretacea ..	X	—	P (?)	P	P
Tapes radiatus ..	X	—	P (?)	—	P
Venerupis macrophylla ..	X	P	—	P	P
MESODESMATIDAE					
Mesodesma glaboratum ..	X	—	—	—	P
MACTRIDAE					
Mactra gibbosula ..	XO	—	P (?)	—	P

TABLE IV—(*Continued*)

SPECIES	DISTRIBUTIONAL FREQUENCY				
	GULF OF KUTCH	BOMBAY (Hornell 1951)	KARWAR (Patil 1952)	MADRAS (Gravely 1941)	KRUSADAI Is. (Satyamurti 1956)
MACTRIDAE—(Contd.)					
M. cuneata	X	—	—	—	P
Spisula triangularis	X	—	—	P	—
Standella nicobarica	XXO	—	P (?)	—	P
S. pellucida	X	—	—	P	—
Lutraria arcuata	X	—	P (?)	—	—
DONACIDAE					
Donax cuneatus	XO	P	—	P	P
PSAMMOBIIDAE					
Psammobia radiata	X	—	P (?)	P	—
Soletellina diphos	XO	—	—	P	—
SEMELIDAE					
Semele crenulata	XO	—	—	—	P
S. striata	X	—	—	—	P
TELLINIDAE					
Tellina coarctata	XX	—	—	P	P
T. pristis	XXO	—	—	P	—
T. ala	XO	—	—	P	P
T. emarginata	XO	—	—	P	—
T. bruguieri	XO	—	—	P	P
Gastrana polygona	XO	P	P (?)	—	—
GLAUCOMYIDAE					
Glaucomya cerea	X	P	—	—	—
SOLENIDAE					
Solen truncatus	XXO	P	P	P	—
Cultellus maximus	X	—	—	P	—
GASTROCHAENIDAE					
Gastrochaena lamellosa	XX	—	—	—	P
PHOLADIDAE					
Jouannetia cumingii	XX	—	—	—	P
Martesia striata	X	P	P (?)	P	P
TEREDINIDAE					
Teredo sp.	XX	—	?	?	—

TABLE V

SUMMARY OF ALL THE MEASUREMENTS TAKEN ON THE VALVES OF THE DIFFERENT SPECIES OF PELECYPODS FROM THE GULF OF KUTCH

Note. The figures within brackets are those of the valves illustrated in this paper. The word 'shell' is used in the second column to describe a specimen the two valves of which are hinged together, and the word 'pair' when the valves have come apart.

Species	Number of valves studied	Length (range) mm.	Height (range) mm.	Depth (range) mm.	Weight (range) gm.	Remarks
Arca gubernaculum ..	7	37·0 to 59·0 (50·2)	31·9 to 48·3 (36·8)	14·1 to 21·3 (16·6)	7·836 to 23·316 (12·691)	
A. granosa ..	3	(25·2) to 63·5	(22·5) to 57·2	(10·5) to 26·6	(3·364) to 41·520	The big one is from Puri (Orissa).
A. rhombea ..	3	24·3 to (26·9)	22·0 to (24·6)	11·0 to (13·0)	2·781 to (4·514)	
A. inaequivalvis ..	2	18·1 to (36·6)	15·4 to (31·5)	6·0 to (13·2)	0·577 to (2·925)	
A. tortuosa ..	8	15·1 to (29·1)	7·9 to (13·0)	3·0 to (6·1)	0·148 to (0·735)	
A. symmetrica ..	3	15·6 to (16·8)	10·8 to (13·2)	5·0 to (6·2)	0·320 to (0·564)	
A. navicularis ..	1	(29·4)	(17·0)	(8·4)	(1·749)	
A. avellana ..	10	13·5 to (25·0)	8·3 to (14·5)	4·4 to (8·3)	0·182 to (1·139)	
A. fusca ..	41	23·3 to (38·8)	12·6 to (26·0)	4·2 to (8·3)	0·613 to (3·054)	All were caught alive.
A. complanata ..	16	11·1 to (26·6)	7·0 to (20·5)	3·0 to (6·6)	0·070 to (1·681)	
A. bistrigata ..	3	(33·3) to 37·3 (17·7)	(18·0) to 20·4 (10·0)	(7·9) to 9·2 (4·1)	(1·735) to 2·537 (0·294)	Figs. 12a & 12b Figs. 12c & 12d
Barbatia obliquata ..	1 shell	(40·5)	(16·0)	(6·5)	(1·632)	
Glycimeris taylori ..	59	8·8 to (25·7)	7·3 to (24·5)	2·0 to (8·1)	0·078 to (2·267)	Smaller ones are very common.
Mytilus viridis ..	2	(30·8) to 109·6	(16·5) to 52.5	(6·0) to 18·0	(0·952) to 21·620	
Modiolus metcalfei ..	3	(41·0)	(21·5)	(8·2)	(1·419)	All of same size.

Septifer bilocularis	..	1	(19·4)	(11·2)	(4·6)	(0·358)	
Lithophaga cinnamomea	..	1 shell	(23·2)	(10·5)	(6·6)	(1·838)	Weight of the whole shell
L. sp. (near *cinnamomea*)	..	4 pairs	22·8 to 27·3 (27·2)	8·3 to 10·4 (9·8)	4·7 to 5·8 (5·8)	0·780 to 1·436 (1·436)	do. do.
L. sp. (near *teres*)	..	18 pairs	14·3 to 34·0 (26·2)	6·0 to 12·2 (9·0)	2·8 to 6·2 (5·0)	0·133 to 0·927 (0·927)	do.
L. teres	..	8 pairs	18·0 to 43·3 (32·6)	6·0 to 13·5 (10·0)	3·5 to 5·8 (4·2)	0·305 to 0·850 (0·724)	do. do.
L. nigra	..	14 pairs	18·3 to 73·0 (40·0)	4·4 to 18·0 (10·6)	2·0 to 7·9 (4·6)	0·072 to 1·396* (0·794)	do. * Only one dry valve
Pinctada vulgaris	..	23	44·1 to 67·3 (59·3)	40·0 to 77·0 (53·0)	7·0 to 18·4 (7·0)	4·339 to 43·975 (10·245)	
Pinna bicolor	..	15 pairs	125·0 to 235·0 (200·0)	63·0 to 145·0 (104·0)	7·1 to 21·0 (16·6)	5·232 to 72·0 (47·0)	
P. atropurpurea	..	4 pairs	(264·0)	(114·0)	(20·0)	(109·0)	All of nearly same size
Pecten tranquebaricus	..	1	(24·2)	(26·7)	(6·4)	(1·094)	However we have a large no. of these shells from Trivandrum (Kerala)
P. distans	..	2	21·5 to (25·5)	21·5 to (26·2)	2·7 to (2·9)	0·365 to (0·863)	
P. crassicostatus	..	1	(44·0)	(42·0)	(11·9)	(2·574)	
Pecten pyxidatus	..	2	41·6 to (43·2)	39·7 to (42·3)	9·5 to (10·6)	2·726 to (3·639)	
Spondylus layardi	..	1	(45·0)	(49·9)	(12·5)	(8·608)	
Lima lima	..	1	(31·5)	(26·9)	(7·8)	(2·431)	
Anomia achaeus	..	1	(36·0)	(34·1)	(9·4)	(2·736)	
Placenta placenta	..	7	86·0 to 106·0 (93·0)	.. ..	.. ..	17·5 to 27·827 (17·5)	Only the diameters have been given
Ostrea madrasensis	..	1	(88·0)	(167·0)	..	(430·0)	Left valve
O. folium	..	1 shell	(25·5) (22·7)	(35·0) (29·4)	(14·3) (8·0)	(6·526) (3·687)	Left valve Right valve
Crassatella rostrata	..	9	13·7 to (24·4)	9·8 to (18·0)	2·3 to (5·8)	0·224 to (1·630)	
Cardita bicolor	..	59	9·0 to 36·7 (27·0)	8·5 to 31·6 (24·4)	3·3 to 14·2 (10·3)	0·165 to 9·608 (3·084)	

TABLE V

SUMMARY OF ALL THE MEASUREMENTS TAKEN ON THE VALVES OF THE DIFFERENT SPECIES OF PELECYPODS FROM THE GULF OF KUTCH

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A. granosa ..	3	(25·2) to 63·5	(22·5) to 57·2	(10·5) to 26·6	(3·364) to 41·520	The big one is from Puri (Orissa).
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A. inaequivalvis ..	2	18·1 to (36·6)	15·4 to (31·5)	6·0 to (13·2)	0·577 to (2·925)	
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A. symmetrica ..	3	15·6 to (16·8)	10·8 to (13·2)	5·0 to (6·2)	0·320 to (0·564)	
A. navicularis ..	1	(29·4)	(17·0)	(8·4)	(1·749)	
A. avellana ..	10	13·5 to (25·0)	8·3 to (14·5)	4·4 to (8·3)	0·182 to (1·139)	
A. fusca ..	41	23·3 to (38·8)	12·6 to (26·0)	4·2 to (8·3)	0·613 to (3·054)	All were caught alive.
A. complanata ..	16	11·1 to (26·6)	7·0 to (20·5)	3·0 to (6·6)	0·070 to (1·681)	
A. bistrigata ..	3	(33·3) to 37·3 (17·7)	(18·0) to 20·4 (10·0)	(7·9) to 9·2 (4·1)	(1·735) to 2·537 (0·294)	Figs. 12a & 12b Figs. 12c & 12d
Barbatia obliquata ..	1 shell	(40·5)	(16·0)	(6·5)	(1·632)	
Glycimeris taylori ..	59	8·8 to (25·7)	7·3 to (24·5)	2·0 to (8·1)	0·078 to (2·267)	Smaller ones are very common.
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Modiolus metcalfei ..	3	(41·0)	(21·5)	(8·2)	(1·419)	All of same size.
Septifer bilocularis ..	1	(19·4)	(11·2)	(4·6)	(0·358)	
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L. sp. (near *cinnamomea*) ..	4 pairs	22·8 to 27·3 (27·2)	8·3 to 10·4 (9·8)	4·7 to 5·8 (5·8)	0·780 to 1·436 (1·436)	do. do.
L. sp. (near *teres*) ..	18 pairs	14·3 to 34·0 (26·2)	6·0 to 12·2 (9·0)	2·8 to 6·2 (5·0)	0·133 to 0·927 (0·927)	do.
L. teres ..	8 pairs	18·0 to 43·3 (32·6)	6·0 to 13·5 (10·0)	3·5 to 5·8 (4·2)	0·305 to 0·850 (0·724)	do. do.
L. nigra ..	14 pairs	18·3 to 73·0 (40·0)	4·4 to 18·0 (10·6)	2·0 to 7·9 (4·6)	0·072 to 1·396* (0·794)	do. * Only one dry valve
Pinctada vulgaris ..	23	44·1 to 67·3 (59·3)	40·0 to 77·0 (53·0)	7·0 to 18·4 (7·0)	4·339 to 43·975 (10·245)	
Pinna bicolor ..	15 pairs	125·0 to 235·0 (200·0)	63·0 to 145·0 (104·0)	7·1 to 21·0 (16·6)	5·232 to 72·0 (47·0)	
P. atropurpurea ..	4 pairs	(264·0)	(114·0)	(20·0)	(109·0)	All of nearly same size
Pecten tranquebaricus ..	1	(24·2)	(26·7)	(6·4)	(1·094)	However we have a large no. of these shells from Trivandrum (Kerala)
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Spondylus layardi ..	1	(45·0)	(49·9)	(12·5)	(8·608)	
Lima lima ..	1	(31·5)	(26·9)	(7·8)	(2·431)	
Anomia achaeus ..	1	(36·0)	(34·1)	(9·4)	(2·736)	
Placenta placenta ..	7	86·0 to 106·0 (93·0)	.. ..	.. ..	17·5 to 27·827 (17·5)	Only the diameters have been given
Ostrea madrasensis ..	1	(88·0)	(167·0)	..	(430·0)	Left valve
O. folium ..	1 shell	(25·5) (22·7)	(35·0) (29·4)	(14·3) (8·0)	(6·526) (3·687)	Left valve Right valve
Crassatella rostrata ..	9	13·7 to (24·4)	9·8 to (18·0)	2·3 to (5·8)	0·224 to (1·630)	
Cardita bicolor ..	59	9·0 to 36·7 (27·0)	8·5 to 31·6 (24·4)	3·3 to 14·2 (10·3)	0·165 to 9·608 (3·084)	

TABLE V—(*Continued*)

Species		Number of valves studied	Length (range) mm.	Height (range) mm.	Depth (range) mm.	Weight (range) gm.	Remarks
Beguina variegata	..	38	12·0 to 29·3 (23·6)	7·6 to 18·0 (17·0)	3·4 to 10·5 (6·8)	0·161 to 3·459 (1·072)	
Libitina vellicata	..	4	(37·5)	(26·4)	(7·0)	(2·884)	All of nearly same size
Lucinia edentula	..	65	21·8 to (61·5)	19·6 to (53·1)	7·3 to (22·8)	0.522 to (11·459)	But the majority are of medium size
Codakia divergens	..	4	16·0 to (21.0)	14·9 to (21·0)	4·0 to (6·8)	0·418 to (1·419)	
Divaricella cumingii	..	4	13·6 to (30·8)	13·6 to (30·0)	3·4 to (11·0)	0·148 to (2·034)	
Chama spinosa	..	1	(18·5)	(19·6)	(6·7)	(1·029)	
C. fragrum	..	1	(21·5)	(20·6)	(6·7)	(1·422)	
C. reflexa	..	1	(19·0)	(18·1)	(10·0)	(1·510)	
Cardium asiaticum	..	2	32·7 to (44·3)	32·6 to (45·0)	12·7 to (19·0)	1·584 to (5·920)	
C. assimile	..	25	32·5 to 66·2 (43·0)	36·6 to 84·5 (52·2)	13·2 to 28·6 (20·5)	4·957 to 46·991 (16·084)	
C. australe	..	3	24·2 to 33·0 (28·0)	24·2 to 35·0 (27·5)	10·6 to 14·4 (11·5)	1·747 to 5·265 (2·590)	
C. flavum	..	9	15·3 to (41.7)	16·0 to (43·3)	5·2 to (15·0)	0·406 to (9·521)	
C. setosum	..	11	16·3 to 41·4 (25·1)	13·0 to 30·6 (21·3)	5·0 to 11·5 (8·0)	0·413 to 3·763 (1·565)	
Meretrix meretrix	..	15	27·9 to (63·0)	23·9 to (55·5)	8·2 to (19·3)	3·132 to (26·366)	
M. casta	..	1	(21·1)	(16·2)	(6·0)	(0·980)	
Paphia textile	..	35	21·4 to 59·0 (54·5)	15·0 to 43·2 (38·4)	4·0 to 13·0 (12·0)	0·410 to 12·508 (8·492)	
P. malabarica	..	13	19·0 to 59·4 (49·5)	14·5 to 47·0 (39·1)	3·4 to 15·8 (10·2)	0·176 to 5·467 (2·882)	
P. alapapiliones	..	5	33·3 to (48·6)	19·0 to (28·4)	5·0 to (9·0)	0·968 to (5·371)	
Pitar erycina	..	11	18·7 to 56·7 (50·0)	15·0 to 47·1 (39·2)	5·0 to 15·4 (15·3)	0·376 to 14·700 (10·470)	
P. nobilis	..	4	22·2 to (26·2)	17·0 to (20·3)	5·5 to (6·8)	0·888 to (1·707)	
Circe scripta	..	35	20·0 to (53·2)	17·5 to (48·0)	2·4 to (8·5)	0·634 to (13·750)	

Venus chemnitzii	9	47·6 to 55·6 (55·0)	40·0 to 46·1 (46·1)	15·2 to 19·8 (19·8)	10·298 to 15·894 (15·894)	
V. reticulata	6	45·0 to (71·4)	41·0 to (66·1)	13·5 to (23·7)	11·594 to (32·858)	
Sunetta scripta	4	19·5 to (31·2)	14·6 to (24·0)	3·5 to (7·2)	0·527 to (2·718)	
Gafrarium divaricatum	89	11·3 to 40·5 (35·7)	9·6 to 36·4 (31·4)	2·4 to 10·0 (8·0)	0·167 to 7·364 (4·985)	Most of these are of large size
G. tumidum	30	21·7 to 52·7 (29·5)	20·0 to 42·0 (32·6)	5·8 to 21·0 (15·0)	1·597 to 39·902 (12·235)	
Dosinia puella	31	17·0 to 33·5 (26·8)	17·0 to 33·0 (26·8)	4·3 to 10·3 (7·5)	0·412 to 5·575 (1·823)	
D. cretacea	4	9·3 to (26·7)	9·0 to (26·5)	2·2 to (7·7)	0·072 to (3·292)	
Tapes radiatus	3	20·3 to (22·4)	13·3 to (14·2)	4·0 to (4·5)	0·428 to (0·487)	All of nearly same size
Venerupis macrophylla	5	18·6 to 22·5 (18·6)	13·0 to 14·5 (14·5)	4·0 to 5·0 (5·0)	0·413 to 0·487 (0·487)	
Mesodesma glabratum	12	24·4 to (35·0)	18·6 to (26·0)	5·6 to (8·1)	1·293 to (4·217)	
Mactra gibbosula	5	22·8 to (31·5)	19·4 to (25·0)	6·1 to (8·7)	0·629 to (1·994)	
M. cuneata	4	22·0 to (25·0)	19·0 to (21·6)	6·5 to (7·7)	0·835 to (1·273)	
Spisula triangularis	1	(34·8)	(19·2)	(5·8)	(1·789)	
Standella nicobarica	37	26·4 to 47·0 (42·3)	17·6 to 29·0 (27·6)	5·0 to 8·4 (8·4)	0·540 to 1·840 (1·840)	
S. pellucida	3	32·6 to 51·6 (34·0)	20·0 to 34·5 (20·9)	5·9 to 10·0 (6·1)	1·192 to 2·470 (1·192)	However, 10 more examples were collected from Kiu point (Byet Island) in Sept. 1963, (G. of Kutch)
Lutraria arcuata	3	(61·5) to 79·6	(30·7) to 36·7	(8·5) to 9·5	(4·332) to 8·607	
Donax cuneatus	14	18·3 to (31·2)	12·8 to (22·2)	3·7 to (5·8)	0·475 to (1·911)	
Psammobia radiata	3	70·0 to (74·7)	34·0 to (34·4)	(9·2) to 10·0	4·098 to (7·466)	
Soletellina diphos	19	18·0 to (28·0)	10·0 to (15·7)	2·3 to (4·0)	0·064 to (0·462)	
Semele crenulata	18	21·0 to 37·0 (31·8)	18·7 to 33·7 (30·0)	4·0 to 8·0 (6·7)	0·305 to 3·774 (1·720)	
S. striata	4	26·6 to (41·5)	25·5 to (38·3)	5·3 to (9·0)	1·054 to (4·482)	
Tellina coarctata	1	(58·5)	(47·7)	(16·7)	(6·888)	
T. pristis	33	18·5 to 47·2 (46·0)	14·0 to 36·7 (36·7)	2·3 to 8·4 (7·0)	0·146 to 4·819 (4·819)	

TABLE V—(*Continued*)

Species	Number of valves studied	Length (range) mm.	Height (range) mm.	Depth (range) mm.	Weight (range) gm.	Remarks
Beguina variegata ..	38	12·0 to 29·3 (23·6)	7·6 to 18·0 (17·0)	3·4 to 10·5 (6·8)	0·161 to 3·459 (1·072)	
Libitina vellicata ..	4	(37·5)	(26·4)	(7·0)	(2·884)	All of nearly same size
Lucinia edentula ..	65	21·8 to (61·5)	19·6 to (53·1)	7·3 to (22·8)	0.522 to (11·459)	But the majority are of medium size
Codakia divergens ..	4	16·0 to (21.0)	14·9 to (21·0)	4·0 to (6·8)	0·418 to (1·419)	
Divaricella cumingii ..	4	13·6 to (30·8)	13·6 to (30·0)	3·4 to (11·0)	0·148 to (2·034)	
Chama spinosa ..	1	(18·5)	(19·6)	(6·7)	(1·029)	
C. fragrum ..	1	(21·5)	(20·6)	(6·7)	(1·422)	
C. reflexa ..	1	(19·0)	(18·1)	(10·0)	(1·510)	
Cardium asiaticum ..	2	32·7 to (44·3)	32·6 to (45·0)	12·7 to (19·0)	1·584 to (5·920)	
C. assimile ..	25	32·5 to 66·2 (43·0)	36·6 to 84·5 (52·2)	13·2 to 28·6 (20·5)	4·957 to 46·991 (16·084)	
C. australe ..	3	24·2 to 33·0 (28·0)	24·2 to 35·0 (27·5)	10·6 to 14·4 (11·5)	1·747 to 5·265 (2·590)	
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Meretrix meretrix ..	15	27·9 to (63·0)	23·9 to (55·5)	8·2 to (19·3)	3·132 to (26·366)	
M. casta ..	1	(21·1)	(16·2)	(6·0)	(0·980)	
Paphia textile ..	35	21·4 to 59·0 (54·5)	15·0 to 43·2 (38·4)	4·0 to 13·0 (12·0)	0·410 to 12·508 (8·492)	
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Venus chemnitzii ..	9	47·6 to 55·6 (55·0)	40·0 to 46·1 (46·1)	15·2 to 19·8 (19·8)	10·298 to 15·894 (15·894)	
V. reticulata ..	6	45·0 to (71·4)	41·0 to (66·1)	13·5 to (23·7)	11·594 to (32·858)	
Sunetta scripta ..	4	19·5 to (31·2)	14·6 to (24·0)	3·5 to (7·2)	0·527 to (2·718)	
Gafrarium divaricatum ..	89	11·3 to 40·5 (35·7)	9·6 to 36·4 (31·4)	2·4 to 10·0 (8·0)	0·167 to 7·364 (4·985)	Most of these are of large size
G. tumidum ..	30	21·7 to 52·7 (29·5)	20·0 to 42·0 (32·6)	5·8 to 21·0 (15·0)	1·597 to 39·902 (12·235)	
Dosinia puella ..	31	17·0 to 33·5 (26·8)	17·0 to 33·0 (26·8)	4·3 to 10·3 (7·5)	0·412 to 5·575 (1·823)	
D. cretacea ..	4	9·3 to (26·7)	9·0 to (26·5)	2·2 to (7·7)	0·072 to (3·292)	
Tapes radiatus ..	3	20·3 to (22·4)	13·3 to (14·2)	4·0 to (4·5)	0·428 to (0·487)	All of nearly same size
Venerupis macrophylla ..	5	18·6 to 22·5 (18·6)	13·0 to 14·5 (14·5)	4·0 to 5·0 (5·0)	0·413 to 0·487 (0·487)	
Mesodesma glabratum ..	12	24·4 to (35·0)	18·6 to (26·0)	5·6 to (8·1)	1·293 to (4·217)	
Mactra gibbosula ..	5	22·8 to (31·5)	19·4 to (25·0)	6·1 to (8·7)	0·629 to (1·994)	
M. cuneata ..	4	22·0 to (25·0)	19·0 to (21·6)	6·5 to (7·7)	0·835 to (1·273)	
Spisula triangularis ..	1	(34·8)	(19·2)	(5·8)	(1·789)	
Standella nicobarica ..	37	26·4 to 47·0 (42·3)	17·6 to 29·0 (27·6)	5·0 to 8·4 (8·4)	0·540 to 1·840 (1·840)	
S. pellucida ..	3	32·6 to 51·6 (34·0)	20·0 to 34·5 (20·9)	5·9 to 10·0 (6·1)	1·192 to 2·470 (1·192)	However, 10 more examples were collected from Kiu point (Byet Island) in Sept. 1963, (G. of Kutch)
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Psammobia radiata ..	3	70·0 to (74·7)	34·0 to (34·4)	(9·2) to 10·0	4·098 to (7·466)	
Soletellina diphos ..	19	18·0 to (28·0)	10·0 to (15·7)	2·3 to (4·0)	0·064 to (0·462)	
Semele crenulata ..	18	21·0 to 37·0 (31·8)	18·7 to 33·7 (30·0)	4·0 to 8·0 (6·7)	0·305 to 3·774 (1·720)	
S. striata ..	4	26·6 to (41·5)	25·5 to (38·3)	5·3 to (9·0)	1·054 to (4·482)	
Tellina coarctata ..	1	(58·5)	(47·7)	(16·7)	(6·888)	
T. pristis ..	33	18·5 to 47·2 (46·0)	14·0 to 36·7 (36·7)	2·3 to 8·4 (7·0)	0·146 to 4·819 (4·819)	

TABLE V—(*Continued*)

Species	Number of valves studied	Length (range) mm.	Height (range) mm.	Depth (range) mm.	Weight (range) gm.	Remarks
T. ala						
(*a*) without keel ..	11	20·6 to (30·7)	14·2 to (21·4)	2·4 to (3·7)	0·186 to (0·846)	Figs. 82a & 82b
(*b*) with keel ..	15	18·3 to 32·5	13·7 to 23·4	2·5 to 4·4	0·136 to 0·849	Figs. 83a & 83b
T. emarginata ..	2	(28·8) (28·4)	(20·0) (16·5)	(4·3) (3·8)	(0·771) (0·435)	Both of nearly same size
T. bruguieri (both varieties) ..	17	32·0 to (38·0)	28·0 to (34·7)	6·1 to (9·6)	1·922 to (4·372)	
Gastrana polygona ..	1 shell	(45·0)	(30·6)	(10·0)	(5·834)	
Glaucomya cerea ..	14	14·9 to (33·5)	7·3 to (22·0)	2·5 to (8·5)	0·069 to (1·947)	
Solen truncatus ..	21	37·0 to 127·0 (120·6)	6·0 to 21·2 (19·5)	2·1 to 7·1 (7·6)	0·101 to 4·685 (5·101)	Mostly caught alive
Cultellus maximus ..	5	41·0 to (73·7)	11·5 to (20·8)	3·0 to (6·6)	0·455 to (3·570)	
Gastrochaena lamellosa ..	10	13·0 to (26·7)	5·6 to (11·3)	2·0 to (3·7)	0·022 to (0·182)	
Jouannetia cumingii ..	5 shells	(20·5) to 24·6 With the ledge	(15·0) to 17·7 Mean width	..	(0·997) to 1·708 Whole-dry	Whole-dry = Shell with animal dried up inside
Martesia striata ..	4 shells	12·0 to (18·6) Entire shell	..	..	0·081 to (0·340) Whole-dry	
Teredo sp. ..	7 animals	..	..	..	..	See the figures

VII. SUMMARY

A description of 91 species of pelecypods, belonging to 27 families, from the Gulf of Kutch (west India) is presented with illustrations. The various areas surveyed include Pirotan Island, Byet Dwarka, Hanuman Dandi, and Veraval. During the present work it was noticed that some shells change their shape along with growth; hence, for accuracy in description, certain measurements are used which are clearly defined and illustrated. It has been found that valves of some species, although of identical measurements, differ considerably in weight.

An approximate estimate of the relative abundance of different species of pelecypods for the Gulf of Kutch is discussed and tabulated. It is shown that the different species of *Lithophaga* vary from each other in a general way, the shape of the valves of *Gafrarium tumidum* changes with size, and, lastly, the number of the denticles in the hinge-groove or *Meretrix* is related to the size of the valve.

VIII. ACKNOWLEDGEMENTS

I feel deeply indebted to my esteemed colleague Mr. P. K. B. Menon for his ready help and advice, to Professor A. K. Datta Gupta for suggesting the problem, and to Principal S. M. Mitra for constant encouragement during this work. Sincere thanks are also due to my colleague Dr. S. C. Rastogi for scrutinising the manuscript, to my post-graduate students for help in collection, and to Dr. M. L. Roonwal, Director, Zoological Survey of India, for permitting me to use the library of the Survey. Thanks are also due to Dr. H. C. Ray of the Zoological Survey of India and Dr. S. T. Satyamurti of Madras Museum for identifying some of the specimens, and to Professor V. Lakshminarayanan, Director of this Institute, for taking keen interest in the work and partially financing it.

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Eco-toxicology and Control of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon)

III. Burrow temperature

BY

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[*Continued from Vol.* **61** (1): 149]

INTRODUCTION

Being diurnal, the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon), is more exposed to the vagaries of temperature than the nocturnal Indian Gerbille, *Tatera indica indica* (Hardwicke). In the Rajasthan desert the soil surface temperature rises to 55·5° C. whereas for the gerbilles the lethal temperature is 41-42° C. Moreover, gerbilles are unable to tolerate the warm summer afternoon wind (40° C.) for more than 8 to 12 minutes. The Desert Gerbille avoids exposure to this heat and the consequent desiccation of its body by adjusting its daily and seasonal rhythm in summer and winter (Prakash 1962) and by leading a fossorial life.

These interesting facts led many workers to investigate the microclimate inside desert rodent burrows. Vorhies (1945) found that the temperature in the nest chamber, about 45 cm. deep in the earth, of the Banner-tailed Kangaroo Rat, *Dipodomys spectabilis*, shows almost no diurnal fluctuations. During summer months, the temperature in the nest chamber is just below 30° C. Schmidt-Nielsens (1950) worked out the temperature inside the burrows of *Dipodomys spectabilis* and *D. merriami* in the Arizona desert. Petter (1952) also found very little fluctuation inside the burrows of *Psammomys obesus* in Beni-Abbes.

TECHNIQUE EMPLOYED

Our experiment was carried out at the Central Research Farm of the Institute at Jodhpur. Burrow temperatures were measured by Soil Moisture and Temperature Bridge model 200 B and Philips Rod Thermistors type 100·092. The bridge which is Wheatstone type measures the DC resistance of thermistors within the range 23,700 and 5240 ohms, corresponding to 0° and 45° C. respectively, when used with this specific type of thermistor which is supplied with a resistance tolerance of ± 25%. The thermistors were calibrated at different temperatures which were taken into account while recording the final reading. The Philips Rod Thermistor type 100·092 gives temperature readings accurate to ± 0·25° C. It is about 3 cm. long and 0·5 cm. in diameter and is attached to a long wire which is connected to the bridge. Thermistors were inserted in the burrows at various slant depths 50, 100, 150, and 200 cm., corresponding on an average to 25, 70, 120, and 150 cm. vertical depth, by the following two methods. In straight burrows they were inserted with the help of thick graduated flexible wires. In burrows with bends, the thermistor was tied to the tail of the gerbille by means of a thread. After letting the gerbille inside the burrow, it was stopped at the required depth by holding the graduated thermistor wire. The gerbille got rid of the thermistor by cutting the thread. The thermistors were seldom damaged. The hourly observations were taken on two days of every month and there were four replications for each particular depth.

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OBSERVATIONS AND DISCUSSION

Normal temperature pattern at Jodhpur

The climate of Jodhpur is seasonal and the year can be divided into four distinct seasons: winter, hot weather, monsoon, and post-monsoon. The normal air temperature data of Jodhpur, averaged for the period 1901 to 1960, are presented below. These data are recorded by thermometers kept in a well-ventilated Stevenson screen at a height of 120 cm. above ground level.

TABLE I

NORMAL AIR TEMPERATURE AT JODHPUR (° C.)

(*Average of figures for* 1901-1960)

	January	February	March	April	May	June	July	August	September	October	November	December
8-30 a.m. ..	11·1	13·5	18·5	25·8	29·2	29·5	28·2	26·3	25·9	21·5	16·4	12·1
5-30 p.m. ..	23·3	27·0	32·4	37·8	40·7	38·7	34·3	31·9	32·7	34·0	29·7	25·0
Mean maximum	24·2	27·3	32·9	37·9	41·1	39·9	36·0	33·2	34·5	35·4	31·0	26·4
Mean minimum	9·6	11·5	16·8	21·9	26·7	27·1	26·8	25·1	23·8	18·9	13·3	10·3

The characteristic feature of the normal temperature pattern over Jodhpur is the great extremes of temperature. The period from December to February constitutes the winter with January as the coldest month when mean maximum and minimum temperatures are 24·2° and 9·6° C. respectively. In the wake of western disturbance, temperature falls considerably and even frost conditions occur occasionally. In fact the lowest minimum temperature recorded at Jodhpur so far is – 2·2° C. in the month of January. Temperatures begin to rise from March and the period March to June constitutes the hot weather season. May with the mean maximum temperature of 41·1° C. is the hottest month of the year. The highest temperature so far recorded is 48·9° C. With the onset of monsoon showers, which normally occur on the first day of July, temperatures fall and there is less diurnal variation. The mean daily range of temperature which is generally of the order of 13 to 18° C. during other months becomes 8 to 11° C. during this season. After the withdrawal of the monsoon, the temperature curve attains a secondary peak during October and begins to fall during November. These months constitute the post-monsoon season.

In view of the existence of four distinct seasons the recorded hourly temperatures, at soil surface and at slant depths of 50, 100, 150, and 200 cm. inside the burrows, corresponding to each hour from 7 a.m. to 7 p.m., were averaged season-wise. These values are presented in Table II. For the sake of comparison, the seasonal averages of air temperature at Jodhpur for each hour from 7 a.m. to 7 p.m. were computed from the thermograph data for the period 1948 to 1952 and are also included in Table II. These data are available for Jodhpur from 1948 and are published by the Indian Meteorological Department in the respective annual summaries. The thermograph recording these data is placed in a well-ventilated Stevenson screen at a height of nearly 120 cm. above ground level.

Temperature outside burrow

a. Average air temperature. Average hourly air temperatures indicate a well-defined peak corresponding to 4 p.m. during winter, between 4 and 5 p.m. during the hot weather, between 3 and 4 p.m. during monsoon, and at 3 p.m. during post-monsoon season. The average range of day temperatures during the various seasons is as follows :

		RANGE (°C.)	ACTUAL VARIATION (°C.)
Winter	..	13·1 to 24·8	11·7
Hot weather	..	28·1 to 39·3	11·2
Monsoon	..	26·8 to 33·4	6·6
Post-monsoon	..	19·6 to 32·7	13·1

b. Soil surface temperature. The seasonal and hourly variation are the highest at the soil surface. There is a well-defined peak of maximum temperature during all seasons. This occurs at 2 p.m. during winter and hot weather, at 1 p.m. during monsoon, and between 12 noon and 1 p.m. during post-monsoon season; thereby showing that the maximum temperature epoch for soil is generally two to three hours ahead of the maximum temperature epoch of air. The range of soil surface temperatures from 7 a.m. to 7 p.m. recorded during various seasons is as follows :

		RANGE (°C.)	ACTUAL VARIATION (°C.)
Winter	..	11·9 to 39·0	27·1
Hot weather	..	26·7 to 55·5	28·8
Monsoon	..	31·5 to 45·8	14·3
Post-monsoon	..	22·7 to 49·3	26·6

Burrow temperature

In contrast to the air and soil surface temperatures, there is very little hour-to-hour variation of temperatures inside the burrows during the various seasons. The variation of temperature from season to season is also considerably less at all depths. There is no well-defined peak of maximum temperature inside the burrows except in the monsoon and post-monsoon seasons, when a peak is noticed at 50 cm. depth and corresponding to 1 p.m. Generally the burrow temperatures tend to increase during the late afternoon, after 5 p.m. In winter the burrow temperatures are not only higher during the late afternoon but also at 7 a.m., thereby indicating that the burrow is probably uniformly warmer during the night when air and surface temperatures fall considerably, and the gerbille has not to encounter the chilly cold winter night. It is further observed from Table II that in winter, the burrow temperatures averaged over all depths are warmer than the normal air temperature from 7 a.m. to 10 a.m. by 2·0 to 7·1°C., and warmer than soil surface by 1·1 to 7·6°C. from 7 a.m. to 9 a.m., and by 3·7°C. at 7 p.m. In the hot weather, the burrow temperatures are in the range of 33·6 to 37·6 considering all depths, whereas the soil surface temperatures reach as high as 55·5°C. These features indicate clearly that the burrows serve the gerbilles as air-conditioned chambers to avoid the high extremes of temperatures noticed in the arid region. Very little variation with respect to depth is noticed in the burrow temperatures. There is, however, a slight indication of temperature decrease with depth during winter and hot weather periods and of increase with depth during the

TABLE II

HOURLY AIR TEMPERATURES (°C.) AND HOURLY TEMPERATURES (°C.) AT SOIL SURFACE AND AT VARIOUS BURROW DEPTHS

Note. Maximum and minimum temperatures in bold face.

	Temperatures (in °C.) at the following hours of the day												
	07·00	08·00	09·00	10·00	11·00	12·00	13·00	14·00	15·00	16·00	17·00	18·00	19·00
WINTER													
Normal air .. (average for 1948-1952)	**13·1**	**13·1**	14·8	17·5	20·7	22·3	23·6	24·1	24·7	**24·8**	24·5	23·3	21·4
Soil surface ..	—	**11·9**	18·5	26·9	34·1	37·1	38·1	**39·0**	37·1	32·4	28·4	23·2	16·8
50 cm. ..	20·1	**19·9**	20·3	20·3	20·2	20·0	20·1	20·6	20·9	20·9	20·9	21·0	**21·1**
100 cm. ..	**20·5**	19·2	**19·1**	19·2	19·2	19·2	19·3	**19·1**	**19.3**	19·5	19·6	19·8	19·8
150 cm. ..	20·3	19·4	19·6	19·3	**19·2**	19·3	19·6	20·0	20·2	20·4	20·5	20·6	**20·7**
200 cm. ..	19·8	19·6	19·3	19·2	19·2	**19·1**	19·3	19·4	19·8	20·2	20·3	20·4	**20·6**
HOT WEATHER													
Normal air .. (average for 1948-1952)	**28·1**	29·4	31·4	33·2	34·7	36·6	37·7	38·6	39·1	**39·3**	**39·3**	38·6	37·1
Soil surface ..	**26·7**	32·3	37·3	42·0	46·9	49·5	54·0	**55·5**	51·5	45·7	42·8	39·3	37·0
50 cm. ..	35·3	**35·2**	**35·2**	35·4	35·4	35·3	35·4	35·6	36·2	36·6	37·0	**37·6**	**37·6**
100 cm. ..	**33·6**	34·7	**34·7**	34·8	34.9	34·8	34·9	34·7	34·8	35·0	**35·2**	**35·2**	35·0
150 cm. ..	**33·9**	34·0	**33·9**	34·0	34·0	**33·9**	34·2	34·2	34·4	34·6	34·7	35·1	**35·4**
200 cm. ..	34·5	34·5	34·4	34·5	**34·2**	34·4	34·3	34·5	34·7	34·8	34·9	**35·3**	**35·3**

TABLE II (*Continued*)

	Temperatures (in °C.) at the following hours of the day												
	07·00	08·00	09·00	10·00	11·00	12·00	13·00	14·00	15·00	16·00	17·00	18·00	19·00
MONSOON													
Normal air (average for 1948-1952)	**26·8**	27·5	28·4	29·6	30·7	31·3	32·4	33·1	**33·4**	**33·4**	33·2	32·0	31·3
Soil surface	32·1	32·6	34·3	37.7	41·9	44·8	**45·8**	39·7	38·4	37·6	35·7	33·9	**31·5**
50 cm.	**28·5**	30·1	30·8	31·5	32·3	33·5	**34·3**	33·3	32·5	32·0	32·1	32·7	31·6
100 cm.	**27·6**	29·2	31·6	31·8	32·2	32·7	34·3	33·9	34·3	35·0	34·9	34·9	**35·3**
150 cm.	**32·9**	34·5	34·1	34·2	34·3	34·4	34·6	35·2	35·2	35·4	35·5	**35·8**	35·7
200 cm.	—	—	—	—	—	—	—	—	—	—	—	—	—
POST-MONSOON													
Normal air (average for 1948-1952)	**19·6**	20·6	23·4	26·2	29·2	31·1	32·1	32·5	**32·7**	32·5	31·7	30·4	28·1
Soil surface	**22·7**	23·1	30·9	39·1	43·4	**49·3**	**49·3**	47·9	44·9	39·7	33·1	25·8	24·5
50 cm.	**24·6**	24·7	**24·6**	24·7	24·7	24·9	**25·7**	25·4	25·1	25.2	25·3	25·5	25·5
100 cm.	**27·9**	28·0	28·1	28·1	28·1	28·1	28·1	28·2	28·3	28·3	28·6	**28·7**	**28·7**
150 cm.	31·2	**31·3**	**31·3**	31.1	31·1	31·0	30·9	30·8	30·7	30·9	30·9	30·9	**30·4**
200 cm.	29·6	29·7	29·6	29·3	29·3	**29·1**	**29·1**	29·2	29·2	29·5	29·7	29·8	**29·9**

other seasons. The range of the day temperatures at various depths in the burrows is given below for various seasons:

SLANT DEPTH	WINTER °C.	HOT WEATHER °C.	MONSOON °C.	POST-MONSOON °C.
50 cm.	19·9 to 21·1 (1·2)	35·2 to 37·6 (2·4)	28·5 to 34·3 (5·8)	24·6 to 25·7 (1·1)
100 cm.	19·1 to 20·5 (1·4)	33·6 to 35·2 (1·6)	27·6 to 35·3 (7·7)	27·9 to 28·7 (0·8)
150 cm.	19·2 to 20·7 (1·5)	33·9 to 35·4 (1·5)	32·9 to 35·8 (2·9)	30·4 to 31·3 (0·9)
200 cm.	19·1 to 20·6 (1·5)	34·2 to 35·3 (1·1)	— —	29·1 to 29·9 (0·8)

It is interesting to note that the burrow temperatures which have generally a small range, varying from 1 to 2°C., show a considerable increase in range during the monsoon when the air and soil temperatures have the minimum range. The increase in range inside the burrows during this season may be attributed to the occasional flooding of the burrows with rain water. Table III gives the normal air temperatures and the burrow temperature averaged for the four depths at the time of maximum temperature epoch of the soil surface temperatures recorded during various seasons.

TABLE III

THE AIR AND BURROW TEMPERATURES AT THE MAXIMUM TEMPERATURE EPOCH OF THE SOIL SURFACE DURING DIFFERENT SEASONS

	Winter 2 p.m °C.	Hot weather 2 p.m. °C.	Monsoon 1 p.m. °C.	Post-monsoon 12 & 1 p.m. °C.
Soil surface ...	39·0	55·5	45·8	49·3
Normal air ...	24·1	38·6	32·4	31·6
Burrow temperature averaged for the four depths ...	19·8	34·7	34·4	28·4
Difference between soil surface and average burrow temperature ...	19·2	20·8	11·4	20·9
Difference between soil surface and normal air temperature ...	14·9	16·9	13·4	17·7

Table III shows that, at the time of maximum temperature epoch of the soil surface temperature, burrows are cooler than the soil surface by 19·2° to 20·9°C. in various seasons except in the monsoon when the difference is 11·4°C., whereas the air temperatures are less than the soil surface temperatures by 13·4° during monsoon and from 14·9° to 17·7°C. during other seasons. This also indicates that the burrows help the gerbilles in avoiding the extreme temperatures of the desert.

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SYNOPSIS

Hourly temperatures inside the burrow of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon), were recorded at Jodhpur. It was found that, at the time of maximum temperature epoch of the soil surface temperature, the burrows are cooler than the soil surface by 19·2° to 20·9°C. in various seasons, except in monsoon when the difference is 11·4°C. only. Fluctuations of temperature inside the burrows are very small. Thus, the burrows serve the gerbilles as air-conditioned chambers to avoid the high extremes of temperatures noticed in the arid regions.

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Observations on the Maturation and Spawning of the Brown Pomfret, *Parastromateus niger* (Bloch) in Saurashtra Waters

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(*With a plate*)

INTRODUCTION

The biology of the Brown Pomfret, *Parastromateus niger* (Bloch), has not been studied so far, though it forms a fishery of considerable importance along all the Indian coast and a major fishery along that of Saurashtra. Our knowledge on pomfrets is very meagre, being restricted to the general accounts given by Chidambaram & Venkataraman (1946), Moses (1947), Devanesan & Chidambaram (1948), and other fisheries reports. Rege (1958) made a preliminary study on the biology of the Silver Pomfret, *Pampus argenteus* (Bloch), in Bombay waters. De Jong's (1939) observations on the spawning habits of *Stromateus niger* in the Java Sea is the only account available on this fish. The importance of biological studies on these fish has been stressed by Gokhale (1960). Detailed studies were, therefore, undertaken on the biology of *P. niger* at Veraval on the Saurashtra coast during 1961-63. The present paper deals with its spawning habits.

MATERIAL AND METHODS

Samples were collected at weekly intervals from the gill-net catches off Veraval. Some representative samples were also taken from Madhwad, Mangrol, and Porbandar. In all 620 fish were examined. Large samples were available during September-November and April-May, when the fish forms a fishery. During other months it is only landed in small quantities, and during June-August fishing is called off because of the south-west monsoon.

The fish were measured, weighed, and dissected. After noting the sex and stage of maturity, the gonads were measured, weighed, and preserved in 5% formalin for further examination. The spawning habits were studied by direct observation on mature and spawning fish and occurrence of juveniles, as well as by the indirect method of studying the size-distribution of the ova in the ovary. Details of the method of study and the discussions are given in different sections of the paper.

All lengths given relate to fork length unless otherwise stated.

STRUCTURE OF THE GONADS

The gonads could be distinguished as ovaries or testes in fish of about 15 cm. and more in length. In fish below this size the gonads take the form of a thin strip of tissue and are indistinguishable. The ovary first becomes apparent as two small, compact lobes, wine-coloured and united at the anterior end, and the testes as two thin, long strips of tissue, white in colour. In both the ovary and the testes, the right lobe is shorter than and about half the length of the left in early stages ; they become subequal later. In contrast to the condition found in most perch-like fishes, the lobes of the gonads extend behind the cloaca on the sides of the intestinal coils, so that the gonads open outside at the anterior end. This condition may be the result of the dorso-ventral deepening of the body, characteristic of the pomfrets.

CLASSIFICATION OF MATURITY STAGES

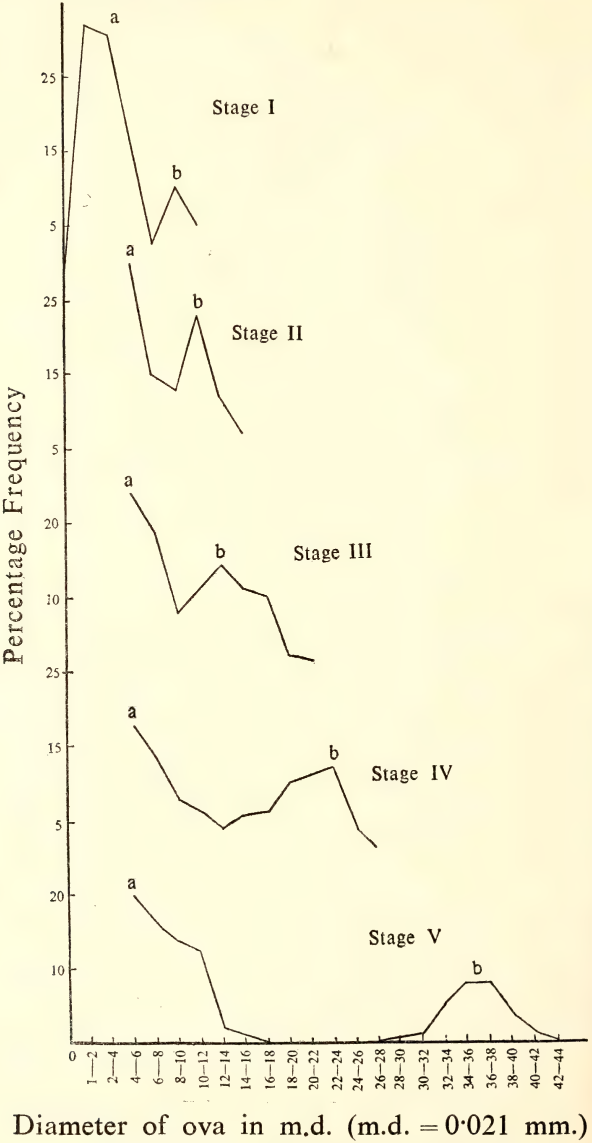
For the study of seasonal changes in the gonad condition, an arbitrary classification of the stages of maturity was made. These stages of maturity, which correspond to the scale adopted by the International Council for the Exploration of the Sea, were based mainly on the diameter and extent of yolk formation in the ova in the case of females, and the presence of milt and the extent of its response to pressure of the testes in the case of males, as followed by Clark (1934) and Bowers & Holliday (1961). They were, however, recognizable externally by such features as colour, shape, and size. The various stages of maturity were defined as follows :

FEMALES

Stage I. Ovaries thin, small piece of tissue, wine-coloured. Microscopic transparent ova, largest ova 0·21 mm. in diameter, not visible to naked eye.

Stage II. Ovaries with compact lobes, right lobe often shorter than the left, pale yellow in colour. Ova with traces of yolk, largest 0·32 mm. in diameter, visible to naked eye. Includes also recovering spent ovaries which are large, bag-like, and bloodshot.

Stage III. Ovaries large, yellow in colour. Ova large, semi-opaque, largest 0·42 mm. in diameter.



Brown Pomfret, *Parastromateus niger* (Bloch)
Ova-size distribution in various stages of maturity

Stage IV. Ovaries large, bright yellow in colour. Large ova completely opaque, fully laden with yolk, largest 0·63 mm. in diameter.

Stage V. Ovaries large and jelly-like, 'speckled' appearance due to large transparent ova. Ova largest, maximum diameter 0·95 mm., still retained inside the follicles.

Stage VI. Ovaries very much distended, ripe ova shed into the cavity of the ovary and oozing out through the oviduct.

Stage VII. Ovaries shrunken, bag-like, and bloodshot. A few large ova may be present.

MALES

Stage I. Testes thin, long strip of tissue, white in colour.

Stage II. Testes slightly larger in size, compact, right lobe shorter than the left, white in colour. Traces of milt in the central core. Also includes spent-recovering, which are large and hard.

Stage III. Testes much longer. Transverse grooves and wavy margins appear. Milt is being formed.

Stage IV. Testes much larger, white in colour, wavy margins and transverse grooves. Milt oozes out when pressed hard.

Stage V. Testes very long and broad, milky white in colour, turgid due to milt, but not oozing.

Stage VI. Testes as above, but oozing milt.

Stage VII. Testes hard, contracted and dull white in colour. Without any milt.

MATURATION AND SIZE-FREQUENCY OF OVA

It is well known that the size distribution of the ova in a teleostean ovary is indicative of its spawning habits. A study of the ova-diameter frequency in the ovaries of *P. niger* was therefore made to show the maturation of ova through various stages and the spawning habits of the fish, on the lines followed by Clark (1934), Hickling & Rutenberg (1936), De Jong (1939), Prabhu (1956), and many others. Samples of ova from ovaries preserved in formalin were spread out evenly on a slide. The diameters of the ova were measured without any selection by means of a micrometer having a magnification of 1 m.d. = 0·021 mm. For determining the exact stage of maturity by the largest ova, only a few ova were measured from each ovary. For the ova-diameter frequency studies, three ovaries from each stage of maturity were taken and 300 to 500 ova were measured from each. Ova below 5 m.d. were disregarded except in stage I, as they were too many and evidently immature. The measurements were grouped in intervals of 2 m.d. and plotted against their percentage frequency. These curves of ova-diameter frequencies are presented in the Plate.

Before going into the details of the study, it is necessary to describe the development of the ova through the various stages of maturity to spawning. The oocytes take their origin from ovigerous lamellae which project into the ovarian cavity from all sides of the ovary. Several batches of oöcytes are produced every season and undergo a remarkable process of maturation, which is accompanied by yolk formation and increase in size. As maturation progresses, the minute clear and transparent ova increase in size and the yolk granules are gradually added, first around the nucleus and then towards the periphery. As yolk formation advances the ova become opaque. Before being spawned, the ova again become transparent and acquire an oil globule which aids in floating on the sea.

Following Walford (1932) and Prabhu (1956), the various stages of development of the ova can be conveniently classified as follows :

1. Immature : Minute, transparent ova with distinct nucleus and clear cytoplasm, up to 0·21 mm. in diameter
2. Maturing : Small semi-opaque ova in which yolk laying has started but is not yet complete, 0·21 to 0·42 mm. in diameter
3. Mature : Large opaque ova, full of yolk, 0·42 to 0·63 mm. in diameter
4. Ripe : Large, transparent ova with an oil globule, about to be spawned, 0·63 to 0·95 mm. in diameter.

The size-distribution of ova in ovaries of stages I to V is plotted in the Plate. In stage I, which is immature, there are only immature eggs extending in diameter from 0 to 12 m.d. with a small mode at 10 m.d. indicating the separation of some eggs. As maturation progresses, this batch of eggs separates from the immature stock, characterized by gradual increase in size and formation of yolk around the nucleus. This batch of eggs is represented by the mode *b* at 12 m.d. separating from the general egg stock, *a*, in stage II. In stage III, this process is carried further forward, with increase in size and yolk formation, and the mode *b* is formed at 16 m.d. In stage IV, the mode *b* at 24 m.d. represents the mature eggs, large, fully yolked, and opaque. Thus, there is only one batch of eggs, distinctly separated from the general egg stock. There is no indication of any other batch of maturing eggs. In stage V, the mature eggs increase very much in size and become 'ripe', transparent with an oil globule. These ripe eggs are represented by the mode *b*, extending from 30 to 44 m.d. and are about to be spawned during this season. All the mature eggs have already become ripe, and a fresh batch of maturing eggs will be produced from the general egg stock probably only after the spawning season.

Thus, in the process of maturation, only one batch of eggs separates from the general egg-stock and undergoes maturation to be spawned during the spawning season. As this single batch of mature ova is distinct from the general egg stock, individuals of this species have a single spawning season in a year, restricted to a short and definite period. De Jong's (1939) observations on the spawning habits of *Stromateus niger* in the Java Sea corroborate these observations. Data on the distribution of different stages of maturity and occurrence of juvenile fish also prove this view, but the spawning season for the species as a whole is considerably protracted because all the fish do not spawn at the same time.

SPAWNING SEASON AND SPAWNING GROUNDS

The spawning season was also determined by direct observation of the condition of the gonads during different months, and by the occurrence of juveniles. The maturity-distribution of females and males during 1962-63 is given in Table I. The data for 1961-62 give a similar picture and hence are not presented here.

The Table shows that, among females, early stages I and II occur throughout the period. Mature fish in stages III and IV start appearing in April and continue till November. Ripe fish (stage V) were recorded only in September, but actual spawners (stage VI) were found in September and October. As there was no fishing during June-July, we do not have data for these months. But the occurrence of spent-recovering fish in August indicates that spawning has already started in July. Spawning is continued till October, with the peak of activity in August-September.

Maturity-distribution among the males presents a similar picture. The early stages occur throughout the period. Stages III and IV occurred during April to November. Stage V was recorded in September. Oozing males (stage VI) were not recorded, but spent males were recorded in October. This also suggests that the spawning period extends from July to October.

Although individual spawning is restricted to a short and definite period, as seen from the ova-diameter frequency studies, the spawning period of the species as a whole is protracted over a period of four months.

Juvenile pomfrets first appear in September, and occur in good numbers in the trawl nets during October to December. This corroborates the spawning period determined for the species. The wide range in the size of the juveniles, from 3 to 15 cm., recorded during November is further evidence of protracted spawning.

Mature fish in stage IV or above and also juvenile fish were recorded throughout a 100-mile stretch along the Saurashtra coast from Diu Head (Madhwad) to Porbandar. This indicates that the fish spawn throughout this stretch of coast. A few females in 'running' condition (stage VI) were recorded off Veraval at 15-20 fathoms. The ripe ova which oozed out from them had a mean diameter of 0·83 mm. (range: 0·74-0·90 mm.) and the oil globule 0·22 mm. (range: 0·21-0·23 mm.).

TABLE I

DISTRIBUTION OF VARIOUS STAGES OF MATURITY OF *Parastromateus niger* DURING AUGUST 1962 TO MAY 1963

Stages of Maturity		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Females	I.	1	..	3	1	44	7	16	1	2	..
	II.	1	1	5	3	1	2	..	5	5	2
	III.	6	7	5	4	..	..	..	..	3	..
	IV.	9	23	15	7	..	1	..	..	4	4
	V.	..	2	..	..	..	..	..	..	..	..
	VI.	..	2	1	..	..	..	..	..	..	..
	VII.	6	12	3	..	..	..	..	..	..	..
Males	I.	..	..	5	5	48	7	13	2	2	..
	II.	3	5	3	1	4	6	..	7	14	2
	III.	5	6	6	6	3	5	..	..	6	6
	IV.	2	3	6	6	..	1	..	..	2	2
	V.	..	1	..	..	..	..	..	..	..	..
	VI.	..	..	..	..	..	..	..	..	..	..
	VII.	..	..	2	..	..	..	..	..	..	..

While the adult fish are pelagic in habit, the juveniles appear to be demersal, as they are caught only in the trawl-nets and bottom-set nets.

SEX RATIO

The distribution of sexes in commercial fish landings during 1962-63 is given in Table II. Fish below 15 cm. in length, i.e. indeterminates, were landed in very small quantities. Out of the total 409 sexed, 195 were males and 214 females, showing a more or less equal distribution of the sexes. In the 15-25 cm. group, males and females were more or less equal in number. Males were predominant, about twice as many as the females in the 25-35 cm. group. Females were remarkably numerous, about four times the males, in the next size-group 35-45 cm. In the last size-group, 45-55 cm., there were no males at all. As regards the distribution of the sexes from month to month, females predominated during August to October, during November to March the sexes were more or less equal in number but irregular in their pattern, and during April-May males were predominant.

TABLE II

SEX RATIO IN VARIOUS SIZE-GROUPS OF *Parastromateus niger* IN COMMERCIAL FISH LANDINGS

—	Size-Groups				Total
	15-25 cm.	25-35 cm.	35-45 cm.	45-55 cm.	
	♂♂ ♀♀	♂♂ ♀♀	♂♂ ♀♀	♂♂ ♀♀	♂♂ ♀♀
1962, Aug.	—	4 : 7	6 : 14	0 : 2	10 : 23
Sept.	—	9 : 8	6 : 37	0 : 2	15 : 47
Oct.	1 : 2	19 : 11	2 : 18	0 : 1	22 : 32
Nov.	5 : 1	12 : 9	1 : 5	—	18 : 15
Dec.	48 : 44	6 : 1	1 : 0	—	55 : 45
1963, Jan.	7 : 6	10 : 3	2 : 1	—	19 : 10
Feb.	13 : 16	—	—	—	13 : 16
March	—	8 : 2	1 : 4	—	9 : 6
April	—	23 : 4	1 : 10	—	24 : 14
May	—	9 : 4	1 : 2	—	10 : 6
Sex ratio over the total period	74 : 69	100 : 49	21 : 91	0 : 5	195 : 214

It was pointed out earlier that the fish spawn during July to October. In accordance with some of the classical observations on other species (Van Oosten 1938 ; Nikolsky 1963), in *P. niger* also the males appear to migrate to the spawning grounds earlier than the females, as indicated by their predominance during April-May. During August-October which is the spawning period, females outnumber the males. It is also found that males are predominant over females in the first size group, become less in number in the next group, and are completely absent in the last group.

SIZE AT FIRST MATURITY

The size at first maturity, an important tool in fishery management (Nikolsky 1963), was determined only approximately.

Fish measuring below 15 cm. were indeterminates and those between 15-25 cm. immatures. Unfortunately, enough fish were not available in the group 25-30 cm. as the selectivity of the gill-nets was rather high. Most of the fish landed were above 30 cm. However, the percentages of mature fish in the various centimetre groups during the spawning season were calculated separately for females and males. The length of the smallest fish with spent gonads was determined. From these observations it was concluded that most of the females attain first maturity at 32 cm. and the males at 30 cm.

ACKNOWLEDGEMENTS

I am thankful to Dr. S. Jones, Director, Central Marine Fisheries Research Institute, Mandapam, for suggesting the problem and providing all the necessary facilities. My thanks are also due to Shri M. V. Pai and Dr. M. J. Pradhan for their help in this study.

SYNOPSIS

The maturation and spawning habits of the Brown Pomfret, *Parastromateus niger* (Bloch), have been studied for the first time. The study was made at Veraval, Saurashtra, where the fish forms a major fishery. The structure of the gonads, and the stages of maturity have been described. The spawning habits were studied by the ova-diameter frequency method, and the distribution of various stages of maturity in time, and the occurrence of juveniles.

The fish has a single, restricted spawning in a year, but the spawning season is considerably protracted because all the fish do not spawn at the same time. Spawning occurs during July to October in the coastal waters off Saurashtra from Diu to Porbandar. The size at first maturity

has been calculated approximately. The sex-ratio in various size-groups during different months is discussed.

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Notes on a Colony of the Whiskered Tern [*Chlidonias hybrida* (Pallas)] in Delhi, with comments on its Breeding Status in India

BY

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AND

USHA GANGULI

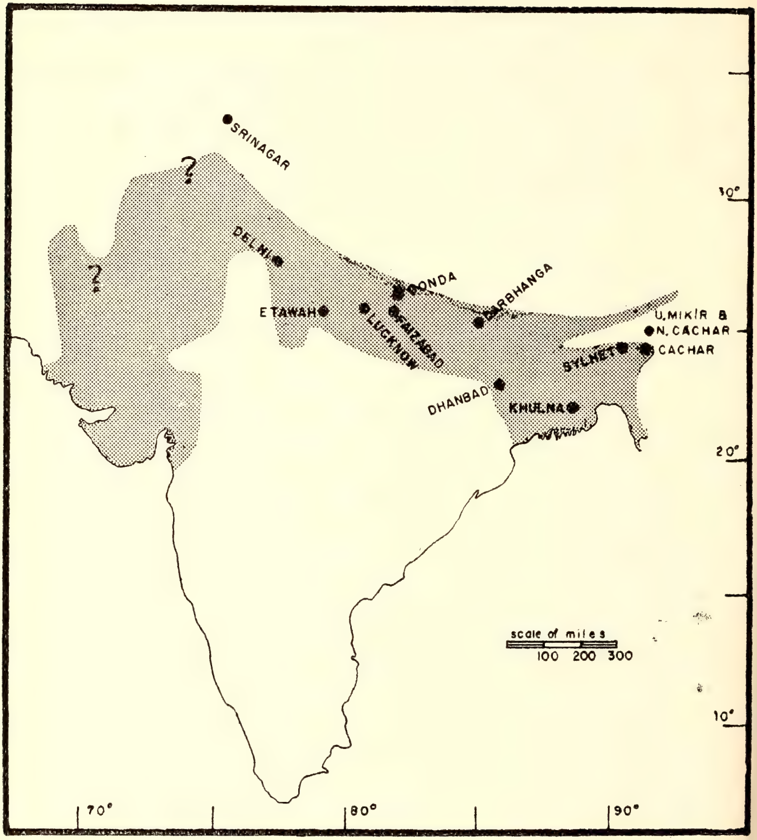
10 *Cavalry Lines, Delhi* 7

(*With a map*)

During the late spring and early summer of 1962 we noticed an increasing number of Whiskered Terns [*Chlidonias hybrida* (Pallas)] on an extensive *jheel* (expanse of shallow water) near the village of Jhatikra, about 20 miles south-west of Delhi, in Delhi State. One bird was seen on 27 May, seven on 16 June, over 30 on 2 July, several on 5 July, and, on 17 July, we located the colony, thus establishing the first record of this species breeding in Delhi.

Our efforts to obtain the services of a water-worthy craft were futile, so we observed the colony from the shore with binoculars and a telescope. Several young, usually in twos, were sitting on a mass of vegetation about a quarter mile from the shore, while adults were scooping small fish from the water (rather than diving for them) and transferring them, while hovering, to the calling young sitting on the aquatic plants. Once, we saw a young bird catch its own fish, drop it, re-catch it, drop it again, and, with seeming resignation, land to receive a fish from an adult. We also saw adults carrying bits of vegetation, obviously in the process of nest construction on a large mat of floating vegetation about half a mile from shore.

On 9 September 1962 UG revisited the *jheel*, when large numbers of terns were seen feeding fledglings. One young bird was seen to call and stamp its feet at the sight of an adult approaching with a fish. Adult


SRINAGAR
?
?
DELHI
ETAWAH
LUCKNOW
FAIZABAD
GONDA
DARBHANGA
DHANBAD
KHULNA
SYLHET
CACHAR
U.MIKIR &
N.CACHAR
30°
20°
10°
70°
80°
90°
scale of miles
100 200 300

Areas in the Indian region where the Whiskered Tern has bred.

birds were still bringing fish to young at dusk. Some adults had apparently begun to lose their breeding plumage, since their bellies were no longer solid black, but streaked with white.

The call of the young, when adults are approaching with food, is a plaintive *chee, chee*. The adults apparently had two calls : a *cherrk* on a slightly falling scale and a harsh *kreek* on a slightly rising scale.

In mid-July 1963, UG again visited the *jheel*, but saw no sign of Whiskered Terns, although she did see birds in breeding plumage elsewhere in Delhi in September. In 1963, the monsoon did not begin until 29 July—one of the latest dates of the century. Consequently, water levels were very low. It is possible that the birds bred later, after the water level had risen, or they may not have bred at all in 1963.

Water levels were too high to permit observations in 1964.

OTHER KNOWN BREEDING LOCALITIES IN INDIA

The several subspecies of the Whiskered Tern breed in south Europe, Africa, Iraq, India, south China, Malay Peninsula, Java, Celebes, Moluccas, New Guinea, and Australia (Alexander 1955 ; Ripley 1961 ; Ticehurst *et al.* 1922, 1926). In India this bird is known to breed only in Kashmir and eastward through the Gangetic Plain to Assam. Non-breeding birds are seen throughout India and Ceylon (Ripley 1961 ; Henry 1955).

By far the most observed population is that occupying several lakes near the resort city of Srinagar, and elsewhere in the Vale of Kashmir (Baker 1935 ; Bates 1923, 1925 ; Bates & Lowther 1952 ; Davidson 1898 ; Lowther 1944 ; Osmaston 1927 ; Phillips 1946 ; Wilson 1899). The exploitation of the eggs in Kashmir is briefly mentioned by Cott (1953).

We have been unable to locate definite breeding records for West Pakistan, although Ripley (1961) says it breeds there. Hume (1873) got second-hand information from local fishermen that it bred during the monsoon in Sind, but this has yet to be confirmed. Waite (1948) observed several of these birds on the Kallar Kahar Lake in the Punjab Salt Range, but never found any nests. These two localities are represented by question-marks on the distribution map.

Four colonies have been observed in Uttar Pradesh. Lowther (1944, 1949) has mentioned a colony in Etawah District, while Field (1922) reports that the Whiskered Tern bred on certain *jheels* in Gonda District in August. Baker (1935) also mentions that eggs were taken by Gill in Oudh, of which Gonda District was a part. Jesse (1899, 1903) reports that this bird was common in Lucknow District, where it bred during August and September, but he felt that the population was decreasing because of drainage of the *jheels*. Baker (1935) says that fresh eggs were taken in September in Fyzabad District.

Although Lowther (1944, 1949) said this bird bred in a few Bihar *jheels*, he specifically mentioned only four colonies in Dhanbad District, of which one colony was active for only a single year. The other Bihar record found was that of Inglis (1899a, 1899b, 1903), who reported breeding activity in Darbhanga District in July and August. In August 1899 the birds were apparently absent and failed to breed where they had bred the year before.

The colonies east of those above are presumably of the subspecies *C. hybrida javanica* (Horsfield), although this population has not been accurately delimited (and Ripley 1961 does not mention it).

In East Pakistan Whiskered Terns have been found breeding in Khulna and Sylhet (Baker 1935). Baker (1899, 1935) said he saw many colonies in Assam, but specifies only those in Cachar and North Cachar (the latter is now the district of United Mikir and North Cachar Hills). Baker (1935) said that the birds in Silchar (Cachar District) normally bred from late June through August, but bred earlier if the rains were early or heavy.

According to Smythies (1953) and Stanford (1946), there is no record of the Whiskered Tern breeding in Burma, although it does breed in Malaya (Smythies 1953). Hopwood (1912) believes it may breed in Arakan.

Mention must also be made of a paper by Hewetson (1956), which says that Whiskered Terns breed on sandbanks in Madhya Pradesh in March and April, before the monsoon. Because this bird is only known to nest on floating marsh vegetation, and because our attempts to substantiate this record were futile, this observation should remain questionable until it can be verified.[1]

DISCUSSION

Some colonies of Whiskered Terns are apparently unstable, for birds will be breeding on a *jheel* one year, but not the next (Inglis 1899b; Lowther 1949). Evidence indicates that nesting (excluding Kashmir) is timed to coincide with the south-west monsoon rains, from June to September, so local water conditions may affect nesting success. It seems, however, that drainage of the *jheels* and raids by egg-collectors would be major factors affecting the abundance of the species. Baker (1935) says that, despite the fact that large numbers of eggs were eaten by villagers in Silchar, the birds continued to lay eggs repeatedly in the robbed nests.

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[1] We might interject that the similar Blackbellied Tern, *Sterna acuticauda* J. E. Gray, does nest on sandbanks.—AUTHORS.

It is obvious that a study needs to be made of the breeding behaviour and ecological requirements of the Whiskered Tern, so that the necessary steps may be taken to protect this lovely marsh dweller. Perhaps, if the reproductive capacity is high, seasons may be set aside when eggs may be taken, to be followed by a period when the nests are protected, to ensure the successful rearing of at least one brood.

Our knowledge of the breeding range of this bird can certainly be enhanced if the marshes and *jheels* of northern India and West Pakistan are observed for activity during the monsoon. For the Delhi colony we were not sure when nesting commenced, how long the young birds were fed by the adults, why there was an apparent range of ages of young birds, or how large the colony was. Here, as in other places, people may raid the nests to obtain eggs.

The authors will be most happy to receive additional records of established breeding colonies of the Whiskered Tern in India.

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Sálim Ali and Rollin H. Baker in the preparation of this paper.

SYNOPSIS

A report is presented on the recently discovered colony of Whiskered Terns in Delhi, India, along with a map and a description of all other known breeding localities of this species in India and Pakistan.

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[The title is punctuated exactly as in the original.— JPD + UG]

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On a collection of Bryophytes made by the Indian Cho Oyu Expedition, 1958[1]

BY

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In 1958 an Indian mountaineering expedition was sent to scale the world's sixth highest peak, Cho Oyu in east Nepal, and to make scientific observations particularly in the natural sciences. Shri R. S. Rao, at that time Regional Botanist, Botanical Survey of India, Eastern Circle, Shillong, was deputed to accompany the expedition and made a good collection of higher plants and cryptogams.

Out of the cryptogams, the lichens were worked out by Dr. D. D. Awasthi (1960). The bryophytic collection, which was sent to us for identification, comprised 37 packets. Except in a few cases, there was no mixture of mosses in the collection. The specimens were collected from an altitude of about 1905-5185 m., which corresponds to the temperate and alpine zones of the Himalayas, where bryophytes abound in variety. The variety is well reflected in the occurrence of 36 species in this collection of 37 packets. *Rhacomitrium heterostichum* (Hedw.) Brid. is a new record for Nepal and the Himalayas.

In enumerating the mosses, Brotherus (1924-25) is followed, and the nomenclature has been made up-to-date on the basis of Wijk *et al.* (1959, 1962). For each taxon, the following data are given: habit, habitat, locality, altitude, field number, and date of collection.

The specimens are deposited in the Herbarium of the Headquarters Organization, Botanical Survey of India, Calcutta.

ENUMERATION

Mosses

DITRICHACEAE

Garckea comosa (Doz. et Molk.) Wijk et Marg. in Taxon 9: 190, 1960. *Grimmia comosa* Doz. et Molk. in Ann. Sc. Nat. Bot., ser. 3, 2: 304, 1844. *Garckea phascoides* C. Muell. in Bot. Zeit. 3 : 865, 1845.

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[1] A paper entitled 'The Indian Cho Oyu Expedition, 1958: Observations of a Botanist Member', by Seshagiri Rao Rolla, appears on pp. 400-9 of Vol. 60 (2) of the *Journal*.—EDS.

[2] Present address: Botanical Survey of India, 10 Chatham Line, Allahabad.

Lax tufts, yellowish brown, on moist soil. Pangboche to Thengpoche, 3965 m. *Rolla* 13832, 28 April 1958.

DICRANACEAE

Campylopodium khasianum (Griff.) Paris, Ind. Bryol. 237, 1894. *Dicranum khasianum* Griff. in Calcutta J. Nat. Hist. 2 : 496, 1842.

Small, greenish brown, dense tufts along rocky moist crevices below *Rhododendron lepidotum* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13752, 20 April 1958.

Dicranodontium attenuatum (Mitt.) Wils. ex Jaeg. in Ber. S. Gall. Nathurw. Ges. 1877-78 : 380, 1880. *Dicranum attenuatum* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 22, 1859.

Dense, silky, yellowish green, tufts along moist rocky crevices below *Rhododendron lepidotum* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13754B, 20 April 1958. It was in association with *Rhocomitrium heterostichum* (Hedw.) Brid.

Dicranodontium uncinatum (Harv.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1877-78 : 381, 1880. *Thysanomitrium uncinatum* Harv. in Hook. Icon. Pl. Rar. t. 22, 1836. et in Lond. Jour. Bot. 2 : 6, 1840.

Soft, silky, pale green cushions on *Rhododendron campanulatum*. Shete-Jumbesi, 3500 m. *Rolla* 13688A, 6 April 1958. It was in mixture with *Plagiothecium nemorale* (Mitt.) Jaeg.

Paraleucobryum enerve (Thed.) Loeske. in Hedwigia 47 : 171, 1908. *Dicranum enerve* Thed. in Hartm. Handb. Skand. Fl. ed. 5. 393, 1849.

Lax cushions along rocky moist crevices below *Rhododendron lepidotum* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13749B. 20 April 1958. It was in association with *Dicranum bonjeanii* De Not. forma.

Symblepharis vaginata (Hook.) Wijk et Marg. in Taxon 8 : 75, 1959. *Didymodon vaginatus* Hook. Icon. Pl. t. 18, fig. 4, 1836.

Dense, close, pale green cushions along moist rocky crevices. Pambrchi-Mingbo, 4100 m. *Rolla* 13757B, 20 April 1958. It was in association with *Dicranum crispifolium* C. Muell.

Dicranum bonjeanii De Not. in *Lisa*, Elenco Muschi Torino 29, 1837.

Yellowish green, close tufts along moist rocky crevices below *Rhododendron lepidotum*. Pambrchi-Mingbo, 4100 m. *Rolla* 13749A, 20 April 1958.

Dicranum crispifolium C. Muell. in Bot. Zeit. 22 : 349, 1864.

Lax tufts, pale green, along moist rocky crevices. Pambrchi-Mingbo, 4100 m. *Rolla* 13757A, 20 April 1958.

Dicranum himalayanum Mitt. in J. Linn. Soc. Bot. Suppl. 1: 14, 1859.

Tall tufts felted below with brown tomentum on *Rhododendron* bushes, also on moist soil near water ditches. Shete-Jumbesi, 3500 m., Pambrchi-Mingbo, 4100 m., Lhenjo-Mozamba Lake, 5030 m. *Rolla* 13685A, 13755, 13908. 6 and 20 April and 12 May 1958.

Dicranoloma fragile Broth. in Nat. Pfl., ed. 2, 10: 209, 1924.

Golden-brown, robust tufts along rocky moraine. Lobucha-Gorashep, 5030 m. *Rolla* 13790, 24 April 1958.

POTTIACEAE

Eucladium verticillatum (Brid.) B. S. G. Bryol. Eur. 1 : 9, 40, 1846. *Weisia verticillata* Brid. Sp. M. 1 : 656, 1801.

Small cushions along dry soil and rocky slopes. Dole-Namche Bazar, 4050 m. *Rolla* 13958, 16 May 1958.

GRIMMIACEAE

Grimmia ovalis (Hedw.) Lindb. in Act. Soc. Sc. Fenn. 10: 75, 1871. *Dicranum ovale* Hedw. Spec. Musc. 140, 1801. *Grimmia commutata* Hueb. Musc. Germ. 185, 1833. *G. ovata* Web. et Mohr, Naturh. Reise Schwedens 132, 1804.

Compact, hoary cushions on rocks all along the track. Lobuche-Gorashep, 5050 m., Gorashep, 5340 m. *Rolla* 13789 and 13796, 24 and 25 April 1958.

Rhacomitrium fuscescens Wils. in Kew J. Bot. 9 : 324, 1857.

Lax, brownish green tufts on rock. Thengpochu-Porcha, 3965 m. *Rolla* 13846, 29 April 1958.

Rhacomitrium heterostichum (Hedw.) Brid. Bryol. Univ. 1 : 214, 1826. *Trichostomum heterostichum* Hedw. M. Frond. 2 : 70, t.25, 1801.

Dense, dark green, many-branched tufts along moist rocky crevices below *Rhododendron lepidotum* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13754A, 20 April 1958. It is a new record for Nepal and the Himalayas.

Rhacomitrium himalayanum (Mitt.) Jaeg. Ad. 1 : 375, 1872. *Grimmia himalayana* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 45, 1859.

Loose, many-branched, hoary tufts along moist rocky crevices below *Rhododendron* sp. Pambrchi-Mingbo, 4100 m. *Rolla* 13751, 20 April 1958.

Rhacomitrium javanicum Doz. et Molk. in Zollinger Syst. Verzeichn. 1 : 25 et 32, 1854.

Erect or decumbent dark green tufts on rocks. Thengpochu-Porcha, 3965 m. *Rolla* 13845, 29 April 1958.

BRYACEAE

Bryum tibetanum Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 72, 1859.

Small cushions along moist soil of Rebno Lake. Lhenjo-Mozamba Lake, 5030 m. *Rolla* 13914, 12 May 1958.

Bryum trachyrhizon C. Muell. in Par. Ind. Bryol. Suppl. 74, 1900.

Dense cushions along moist rocky crevices below *Rhododendron lepidotum* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13753, 20 April 1958.

Bryum turbinatum (Hedw.) Turn. Musc. Hib. 127, 1804. *Mnium turbinatum* Hedw. Spec. Musc. 191, 1801.

Small tufts or cushions along the running stream of Chokkola. Thaparma-Pheriche, 4200 m. *Rolla* 13772A. 21 April 1958. It was in association with *Philonotis lutea* Mitt.

BARTRAMIACEAE

Philonotis lutea Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 63, 1859.

Tall tufts, felted below with brown tomentum, along running stream of Chokkola. Thaparma-Pheriche, 4200 m. *Rolla* 13772B, 21 April 1958.

HOOKERIACEAE

Orontobryum hookeri (Mitt.) Fleisch. in Nov. Guinea 12, Bot. Livr. 2 : 125, 1914. *Stereodon hookeri* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 114, 1859.

Wide, close, brownish green patches on *Rhododendron* sp. Shete-Jumbesi, 3500 m. *Rolla* 13685B, 6 April 1958.

THUIDIACEAE

Thuidium philibertii Limpr. in Laubm. Deutschl. 2 : 835, 1895.

Dense, reddish brown carpets on moist shady soil below *Juniperus* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13748B, 20 April 1958. It was in association with *Ectropothecium sikkimense* (Ren. et Card.) Ren. et Card.

Actinothuidium hookeri (Mitt.) Broth. in Nat. Pfl. 1 (3) : 1020, 1908. *Leskea hookeri* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 132, 1859.

Dense, brownish green carpets on *Rhododendron campanulatum* Shete-Jumbesi, 3500 m. *Rolla* 13687, 6 April 1958.

AMBLYSTEGIACEAE

Cratoneuron filicinum (Hedw.) Spruce, Cat. Musc. Amaz. And. 21, 1867. *Hypnum filicinum* Hedw. Spec. Musc. 285, 1801.

Loose, golden-green carpets along moist soil near water-fall. Namche Bazar-Manjo, 3660 m. *Rolla* 13994A, 26 May 1958.

Drepanocladus uncinatus (Hedw.) Warnst. in Beih. Bot. Centralbl. 13 : 402, 417, 1903. *Hypnum uncinatum* Hedw. Spec. Musc. 289, 1801.

Lax, golden-green carpets along moist rocky crevices below *Rhododendron* sp. Pambrchi-Mingbo, 4100 m. *Rolla* 13750 and 13756, 20 April 1958.

BRACHYTHECIACEAE

Brachythecium buchanani (Hook.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876-77 : 341, 1878. *Hypnum buchanani* Hook. in Trans. Linn. Soc. 9 : 320, t. 28, fig. 3, 1808.

Loose, golden-green mats along rocky crevices. Chule-Lhenju, 4720 m. *Rolla* 13901, 11 May 1958.

ENTODONTACEAE

Entodon rubicundus (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876-77 : 285, 1878. *Stereodon rubicundus* Mitt. in J. Linn. Soc. Suppl. 1 : 108, 1859.

Dense, brownish green mats on rock. Namche Bazar-Thanu, 3580 m. *Rolla* 13865, 5 May 1958.

PLAGIOTHECIACEAE

Plagiothecium nemorale (Mitt.) Jaeg. Ad. 2 : 517, 1880. *Stereodon nemoralis* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 104, 1859.

Dense, silky mats on the bark of *Rhododendron campanulatum*. Shete-Jumbesi 3500 m. *Rolla* 13688B, 6 April 1958.

SEMATOPHYLLACEAE

Sematophyllum tristiculum (Mitt.) Jaeg. Ad. 2 : 458, 1880. *Stereodon tristiculus* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 102, 1859.

Dull green, loose tufts, submerged and along the banks of ice cold lake. Lhenjo-Mozamba Lake, 5185 m. *Rolla* 13912, 12 May 1958

HYPNACEAE

Hypnum revolutum (Mitt.) Jaeg. Ad. 2 : 585, 1880. *Stereodon revolutus* Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 97, 1859.

Loose, brownish green carpet along dry soil and rocky slope. Dole-Namche Bazar, 4050 m. *Rolla* 13957, 16 May 1958.

Ectropothecium sikkimense Ren. et Card. in Bull. Soc. R. Bot. Belg. 41(1) : 109, 1905.

Close, intricate mats of yellowish green colour on moist shady soil below *Juniperus* bushes. Pambrchi-Mingbo, 4100 m. *Rolla* 13748A, 20 April 1958.

POLYTRICHACEAE

Lyellia crispa R. Br. in Trans. Linn. Soc. 12 : 562, 1819.

Loose, brownish green tufts below *Juniperus* bushes with dried capsules. Thengpochu-Porcha, 3965 m. *Rolla* 13847, 29 April 1958.

Pogonatum hexagonum Mitt. in J. Linn. Soc. Bot. Suppl. 1 : 152, 1859.

Dense, dull green tufts on soil amongst boulders. Jumbesi-Takshindo, 3050 m. *Rolla* 13691, 7 April 1958.

Pogonatum microstomum (R. Br.) Brid. Bryol. Univ. 2 : 745, 1827. *Polytrichum microstomum* R. Br. in Trans. Linn. Soc. 12 : 569, 1819.

Loose, dark green tufts on moist soil. Solakumbu. *Rolla* 13826, 27 April 1958.

LIVERWORTS

Marchantia nepalensis Lehm. et Lindenb. in Lehm. Pug. 4 : 10, 1832.

Thallose liverworts on moist soil along small water-fall. Those-Bhander, 1905 m. *Rolla* 13633, 4 April 1958.

Herberta sp.

Leafy liverwort, greyish black on *Rhododendron* sp. Shete-Jumbesi, 3500 m. *Rolla* 13684, 6 April 1958.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. H. Santapau, Director, Botanical Survey of India, for his kind interest and encouragement. They are indebted to Shri R. S. Rao, Regional Botanist, Western Circle, Poona, for putting at their disposal this valuable collection, and to the authorities of the British Museum (Nat. Hist.), London, for confirming some of the identifications.

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Gall-inhabiting Tubuliferous Thysanoptera-I

BY

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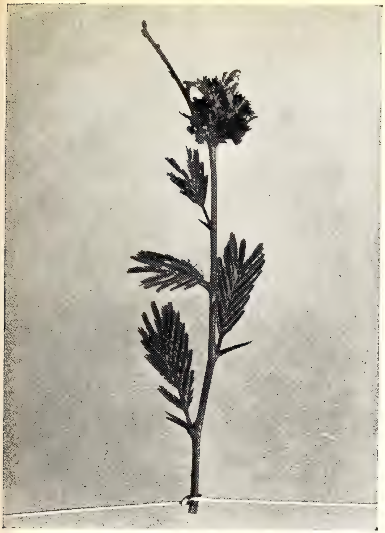
(*With six plates*)

Thysanopterocecidia have become a special branch of thrips study, and the contributions of Karny (1911), Karny & Van Leeuwen Reijnvaan (1913, 1914-16) provide valuable information on gall thrips from the Oriental Region, in particular from Java and adjoining areas. Our knowledge of gall thrips from the Indian mainland is due to Ramakrishna (1928), who records about 20 species. Mani (1948) in his work on Cecidozoa and Zoocecidia provides a consolidated list of the gall-inhabiting thrips. It is a known fact that thrips are primitive gall-makers, producing mostly leaf rolls, leaf folds, leaf wrinkles, and very rarely bud galls, bladder or pouch galls, and horn galls. Studies on gall-inhabiting thrips naturally involve a study of the population within the gall and, consequently, information about: (a) the range of variation of the essential characters of the species involved, (b) the number of species within the gall and their ability to form independent galls, and (c) their host specificity. The observations recorded below are the first of a series to be attempted and, to avoid the monotony of detailed species descriptions, mention is made of the range of variations of some important characters of the species which would be useful for identification.

29 species of gall-inhabiting Tubulifera are discussed below:

1. *Alocothrips hadrocerus* (Karny)
2. *Androthrips flavipes* Schmutz
3. *Androthrips ramachandrai* Karny
4. *Arrhenothrips ramakrishnae* Hood
5. *Arrhenothrips dhumrapaksha* Ramakrishna
6. *Austrothrips cochinchinensis* Karny
7. *Brachythrips dantahasta* Ramakrishna
8. *Cercothrips nigrodentatus* (Karny) (*new record*)
9. *Eothrips coimbatorensis* Ramakrishna

Gall-inhabiting Tubuliferous Thysanoptera



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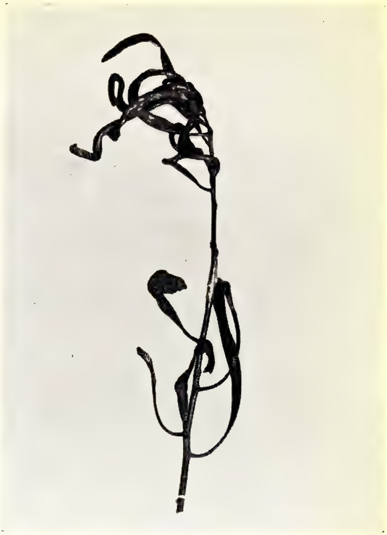

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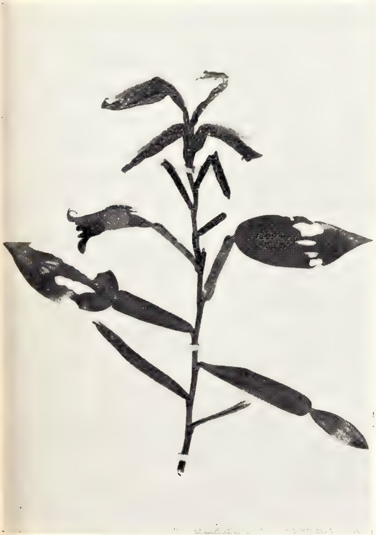

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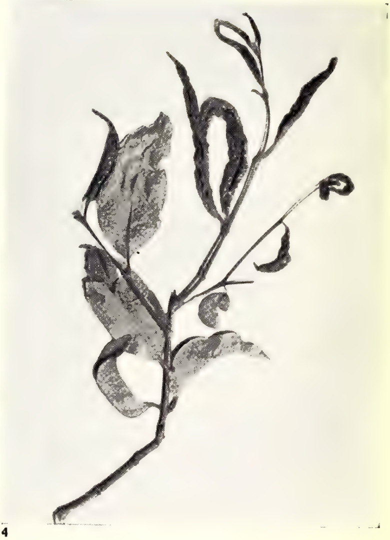

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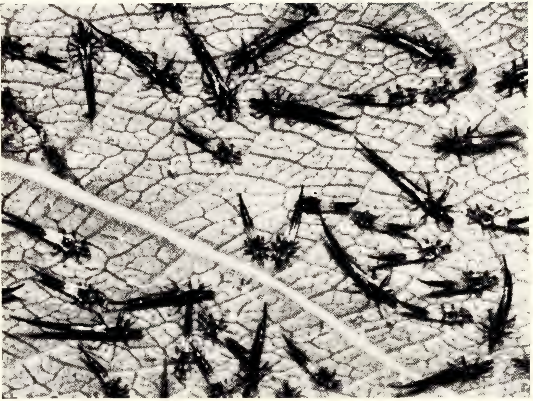
1. *Thilakothrips babuli;* 2. *Eothrips crassicornis;* 3. *Tetradothrips foliiperda;* 4. *Brachythrips dantahasta*

(*Photos : T. N. Ananthakrishnan*)

Gall-inhabiting Tubuliferous Thysanoptera



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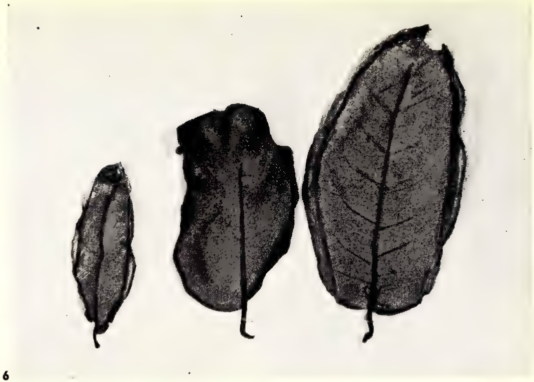

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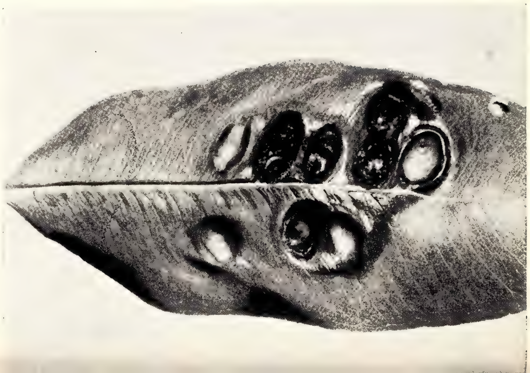

5. *Cercothrips nigrodentatus ;*
6. *Lygothrips jambuvasi ;*
7. *Mallothrips indicus*

(*Photos : T. N. Ananthakrishnan*)

10. *Eothrips crassicornis* (Karny) (*new record*)
11. *Gynaikothrips gracilis* Karny (*new record*)
12. *Gynaikothrips fumipennis* Karny (*new record*)
13. *Gynaikothrips flaviantennatus* Moulton
14. *Gynaikothrips karnyi* Ramakrishna
15. *Gynaikothrips malabaricus* Ramakrishna
16. *Gynaikothrips moultoni* Ramakrishna
17. *Gynaikothrips pallicrus* Karny
18. *Gynaikothrips uzeli* Zimmerman
19. *Liothrips hradecensis* Uzel (*new record*)
20. *Lygothrips jambuvasi* (Ramakrishna)
21. *Mallothrips indicus* Ramakrishna
22. *Mesothrips melinocnemis* Karny
23. *Mesothrips jordani* (Karny)
24. *Mesothrips vitripennis* Karny (*new record*)
25. *Rhynchothrips raoensis* Ramakrishna
26. *Tetradothrips foliiperda* (Karny)
27. *Teuchothrips longus* (Schmutz) (*new record*)
28. *Teuchothrips priesneri* Ananthakrishnan
29. *Thilakothrips babuli* Ramakrishna

Alocothrips hadrocerus (Karny)

Trichothrips hadrocerus Karny, 1926, *Mem. Dept. Agri. Ind., Ent. Ser., Calcutta* **9** (6): 220; Ramakrishna, 1928, ibid. **10** (7): 298; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 41.

Alocothrips hadrocerus Priesner, 1951, *Indian J. Ent.* **13** (2) : 195 ; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 26-27.

This rather uncommon species has been rediscovered after 37 years from the marginal leaf gall of a wild plant, from Shencottah Hills (2500 ft.). Of 15 individuals collected within this gall, 11 are macropterous females, two apterous females, and two brachypterous males. It is a point of interest to observe the divergence in coloration between the three categories of individuals within the same gall. All the macropterous forms are brown to pale brown, with only the antennal segment 3 tinged yellow. The apterous females have head, prothorax, all legs, and all antennal segments yellowish, the rest of the body yellowish brown. The brachypterous forms have an intermediate range of coloration, with legs paler brown, as also antennal segments 6 to 8 brown, rest pale.

Chaetotaxy of the females. Postoculars 45 to 48 ; anteromarginals 32 ; anteroangulars 38 to 43 ; midlaterals 45 to 48 ; postangulars 48 to 54 and epimerals 48 to 64 long. Tube very characteristic of the genus, 168 to 182 long, 98 wide at base, 56-70[1] at apex; accessory fringes on the forewing 7 to 8.

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[1] All measurements in microns.

Material. 11 macropterous females, 2 apterous females, and 2 brachypterous males, within one gall on the leaf of a wild plant, Shencottah Hills, S. India (2500 ft.), 18.viii.1963.

Androthrips flavipes Schmutz

Androthrips flavipes Schmutz, 1915, *Sitz. Akad. Wiss. Wien.* 1031; Karny, 1915, *Zeit. Wiss. Insektenbiol.* **11** : 90; Bagnall, 1918, *A.M.N.H.* **13** (8) : 27-28; Karny, 1926, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **9** (6): 224; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 28.

This species is not known as an independent gall-producer. Several individuals were collected during the present studies from four sources—in the galls of *Mimusops* produced by *Arrhenothrips ramakrishnae*, in the leaf galls of *Memexylon* produced by *Brachythrips dantahasta* Ramk., in the leaf-galls of *Ficus* sp. caused by *Gynaikothrips flaviantennatus* Moulton, and in leaf-galls of *Ficus benjamina* produced by *Gynaikothrips uzeli*. In all these cases *Androthrips* was not the dominant species. During the peak months of their occurrence (Jan. to Mch.), *Androthrips flavipes* number 6 to 8 in many galls and 2 to 3 in other months; their number is much less in the smaller galls of *Memexylon*. Ananthakrishnan (1964) refers to the range of variations in colour and the thoracic chaetotaxy.

Material. 32 females, 19 males inside *Mimusops* galls, Madras, 19.xii.63 and 28.xii.63; 9 females, 5 males, in *Mimusops* galls, Chidambaram, 4.x.63; 8 females, 6 males in leaf-galls of *Memexylon*, Calicut, 5.x.1963; 12 females, 4 males in leaf-galls of *Memexylon*, Agambe Ghat road, 22.i.64; 28 females, 7 males, in *Ficus benjamina* galls, Courtallum, 14.ix.64; 18 females, 4 males, in *Ficus* sp. galls, Madras, 8.v.65.

Androthrips ramachandrai Karny

Androthrips ramachandrai Karny, 1926, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **9** (6): 226; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25**: 44; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 29.

This species is not a true gall-producer and, when present, is associated with *Austrothrips cochinchinensis* Karny within the axillary bud galls of *Calycopteris floribunda.* In the course of the present studies, nearly a hundred galls of different sizes were examined from parts of Kerala, parts of Mysore, and Courtallum (Tirunelveli District) where the host plant is abundant and about 75 individuals were collected. In a medium-sized gall where the number of *Austrothrips cochinchinensis*, the gall-makers, ranges from 300 to 400, such as those examined in Courtallum during the months August-October, the number of *Androthrips ramachandrai* per gall was about the range 9 to 12. The following range of variation is observed in the males and females of this species.

		FEMALE	MALE
Postoculars	..	84-112	70-112
Anteroangulars	..	70-98	56-84
Midlaterals	..	84-112	56-112
Postangulars	..	84-112	70-112
Epimerals	..	98-140	84-126
Forefemoral width	..	112-182	96-168
Prothoracic length	..	140-182	112-168
Tarsal tooth	..	28-42	14-42

Arrhenothrips dhumrapaksha Ramakrishna

Arrhenothrips dhumrapaksha Ramakrishna, 1928, *Mem. Dept. Agri. Ind., Ent. Ser., Calcutta* **10** (7): 280; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25**: 31; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 32.

This species is recorded in considerable numbers from the leaf-fold galls of *Ficus retusa*, from Agambe Forest, Ghat road (Mysore State). The gall resembles that caused by *Gynaikothrips uzeli* on the same host plant. However, in none of the galls examined did both species occur together. The leaves, in particular the terminal leaves, become folded upwards and, due to the thickening of the leaf blade, the sides of the fold assume a slight convexity. Apart from the clouded nature of the wings, the shorter metanotal setae and the anteroangulars shorter than the anteromarginals are very characteristic of *A. dhumrapaksha*, not to speak of the host specificity involved in gall production. Experimental gall induction on *Ficus* leaves by *Arrhenothrips ramakrishnae* did not succeed.

		FEMALE	MALE
Head width	..	210-266	196-252
Postoculars	..	84-126	56-112
Prothoracic length	..	196-266	196-252
Anteroangulars	..	56- 70	36-42
Postangulars	..	98-112	70-84
Epimerals	..	98-126	56-98
Forefemoral width	..	196-266	154-238
Foretarsal tooth	..	70-112	56- 70

Material. 35 females and 18 males from leaf-galls of *Ficus retusa*, Agambe Forest, Ghat road, Mysore State (21.i.1964).

Arrhenothrips ramakrishnae Hood (Plate III, 9)

Arrhenothrips ramakrishnae Hood, 1919, *Insec. Inscit. Menstr.* **7**: 99; Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7): 282; Ananthakrishnan, 1954, *Agra Univ. J. Res.* (*Science*) **3** (2): 463-474; 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 31-32.

This is one of the commonest of gall-producing Tubulifera causing leaf-fold galls on *Mimusops elengi*. Several hundreds of galls and individuals examined from *Mimusops* galls from different regions did not reveal the presence of even a single *Liophlaeothrips vichitravarna* (Ramk.) (= *Rhynchothrips vichitravarna*). It is clear beyond doubt that only *Arrhenothrips ramakrishnae* produces the galls.

Duration of egg and nymphal stages. Egg, 5-6 days; I instar, 3-4 days; II instar, 3-5 days; pre-pupa, 1 day; pupa I, 2-3 days; pupa II, 1 day.

Austrothrips cochinchinensis Karny (Plate V, 15)

Austrothrips cochinchinensis Karny, 1923, *J. Siam. Soc.* **21**: 113; Ramachandra Rao, 1924, *Agr. J. India* **19** (4): 436; Karny, 1926, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **9** (6): 259; Ramakrishna, 1928, ibid. **10** (7): 297; Mani, 1948, *J. Roy. Asia. Soc. Bengal* **14** (2): 69, 107; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 33.

This is the only thrips known to produce the axillary bud galls in *Calycopteris floribunda*. The galls were observed in all stages of development, the larger galls ranging from 25 to 45 mm. in diameter. They were abundant throughout Kerala State and the Kerala-Mysore border area, and in Madras State the author collected them in numbers from Courtallum (Tirunelveli District). The very long, knobbed bristles of the body are very characteristic of the species and the following range is observed in the females:

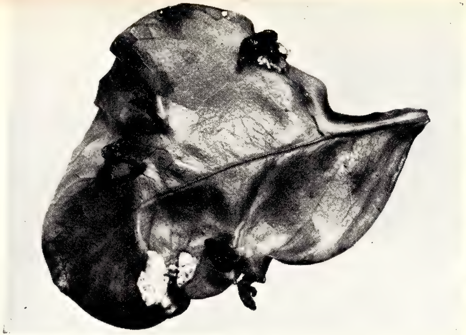
Postoculars 83 to 96, anteroangulars 51 to 64, anteromarginals 58 to 80, midlaterals 64 to 96, postangulars 86 to 96, epimerals 93 to 109. Only two males were observed; measurements: anteroangulars 54, anteromarginal 61, midlateral 86, epimeral 102.

Material. Two males and numerous females, inside galls of *Calycopteris floribunda*, Courtallum, Kerala, and Mysore.

Brachythrips dantahasta Ramakrishna (Plate I, 4)

Brachythrips dantahasta Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7): 294; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25**: 40; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 34.

This species has been known to produce galls on *Memexylon* sp., causing the leaf-margin-roll gall, and in the final stages of gall-production the leaf blade appears swollen, crumpled, twisted, and tuberculated (see Plate I, 4). The distribution of this species, so far observed by the authors, includes mainly Kerala State, Mangalore, and the Agambe Forest areas of Mysore. The head length in the females varies from 196 to 224, in the males 196 to 210, the corresponding widths being 210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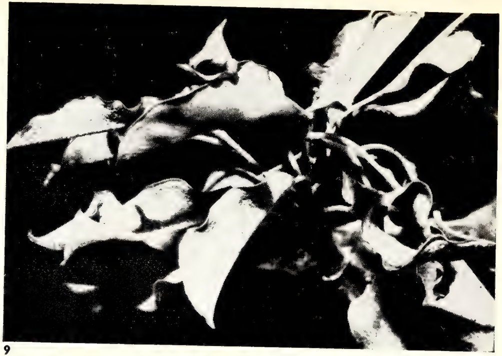
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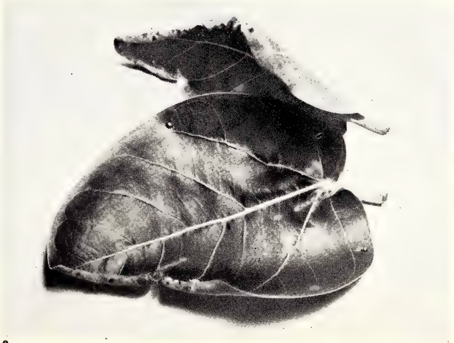
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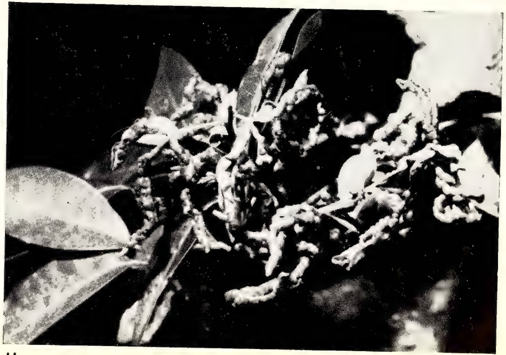
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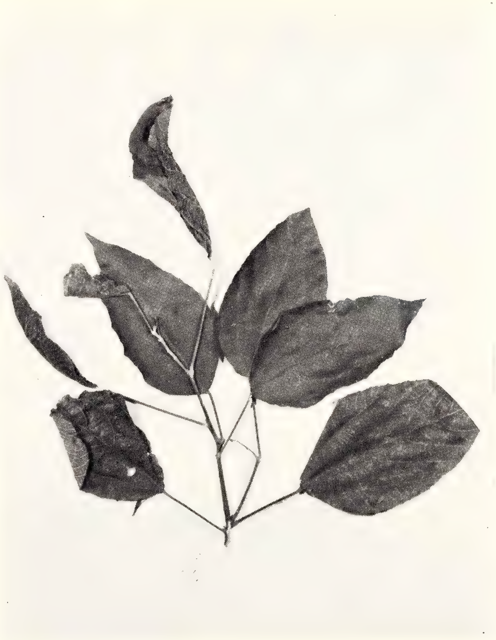
8. *Gynaikothrips moultoni* ; 9. *Arrhenothrips ramakrishnae* ; 10. *Gynaikothrips malabaricus* ;
11. *Teuchothrips priesneri*
(*Photos : T. N. Ananthakrishnan*)

Gall-inhabiting Tubuliferous Thysanoptera



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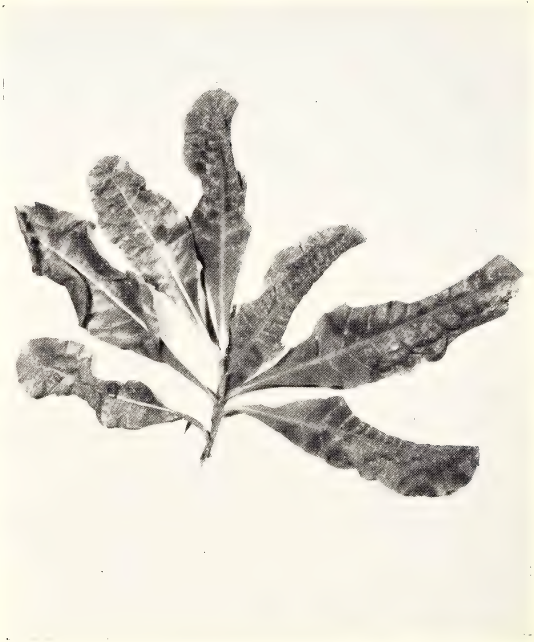
12. *Mesothrips vitripennis*



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13. *Cercothrips nigrodentatus*

Photos : T. N. Ananthakrishnan)

to 226 and 210 to 238 respectively. Very few individuals show the head as long as wide (210).

Prothoracic chaetotaxy. Females: Postoculars 48 to 64, anteroangulars 19 to 22, anteromarginals 19 to 22, midlaterals 29 to 32, postangulars 43 to 48, epimerals 86 to 106, accessory fringes of forewing 6 to 10.

Material. 28 females, 12 males, on leaf galls of *Memexylon*, Calicut, 5.x.63; 32 females, 8 males, on leaf-galls of *Memexylon*, Agambe Forest, Ghat road, Mysore State (20.i.1964); 42 females, 22 males, Courtallum (Tirunelveli District) 13.x.64.

Cercothrips nigrodentatus (Karny) (Plates II, 5 and IV, 13)

Acanthinothrips nigrodentatus Karny, 1930, *Bull. Jard. bot. Buitenzorg* **10** : 120.
Cercothrips nigrodentatus Priesner, 1949, *Bull. Soc. Fouad Ier. Entom.* **33** : 124.

Large colonies of this large-sized Tubuliferan were found feeding on the underside of the leaves of *Planchona valida* from Courtallum, Moodbidri (Mangalore), Hubli, Shencottah Hills, etc. Over two hundred individuals at a time, including the nymphal stages were found concentrated on single leaf making them wrinkled and crumpled.

Prothoracic chaetotaxy. Females: Postoculars 64-74, anteroangulars 32 to 54, anteromarginals 16 to 22, midlaterals 32 to 48, postangulars 16 to 32, epimerals 80 to 112. Males: 32 to 58, 42 to 58, 16 to 22, 38 to 48, 16 to 32, 64 to 96 respectively in the order mentioned for the females.

Eothrips coimbatorensis Ramakrishna

Eothrips coimbatorensis Ramakrishna, 1928, *Mem. Dept. Agri. Ind., Ent. Ser., Calcutta* **10** (7): 298-299; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 40-41.

Eothrips aswamukha Ramakrishna, 1928, *Mem. Dept. Agri. Ind., Ent. Ser., Calcutta* **10** (7): 299-300; Ananthakrishnan, 1954, *J. Zool. Soc. India* **6** (2): 164.

This species has been known to produce the twisted, cylindrical roll-gall of the leaf and very few adults were recorded during the past studies as most of the forms were immature stages. Ananthakrishnan (1964) gives a detailed description of the species with the range of measurements.

Eothrips crassicornis (Karny) (Plate 1, 2)

Dolerothrips crassicornis Karny, 1912, *Marcellia* **11**: 126; Karny, 1913, *Bull. Jard. bot. Buitenzorg* **10** : 84-86; Hood, 1915, *Entomologist* **48** : 106; Priesner, 1949, *Bull. Soc. Fouad Ier Entom.* **33** : 94.

Only 5 females along with some immature stages of this species, which is a new record to India, were collected from an unidentified plant from Horsley Hills, Madanapalle.

TABLE

GALL-INHABITING SPECIES OF *Gynaikothrips* (Females)

(*Measurements in microns*)

Species	Head length / Tube length	Postoculars	Antero-angulars	Antero-marginals	Mid-laterals	Post-angulars	Epimerals	Double fringes
G. flaviantennatus ..	280-322 196-224	80-102	58-80	64-80	96-115	84-128	115-160	9-12
G. fumipennis ..	336-420 280-350	118	51-64	43-68	96-134	130-176	140-176	14-22
G. karnyi ..	220-334 182-210	84-96	51-64	43-64	96-105	147-166	140-160	9-12
G. malabaricus ..	294-322 294-336	48	58-70	48-70	64-77	77-106	128-144	12-14
G. moultoni ..	294-322 252-280	90-96	45-48	42-48	68-74	80-84	96-128	10-13
G. pallicrus ..	280-294 224-238	96-112	54-58	64	112-116	147-152	147-152	11-13
G. uzeli ..	350-364 350-420	32-45	29-32	10-22	22-51	45-64	105-144	18-20

Genus **Gynaikothrips** Karny

Gynaikothrips Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 45 (All major references to the genus provided).

This genus comprises several well-known gall-forming species. Seven species are recorded here : *G. flaviantennatus* Moulton, *G. fumipennis* Karny, *G. karnyi* Bagnall, *G. malabaricus* Ramakrishna, *G. moultoni* Ramakrishna, *G. pallicrus* Karny, and *G. uzeli* Zimmerman. The tabular statement below, indicates the distinctive characters of the species, with the range of variations.

Gynaikothrips flaviantennatus Moulton

Gynaikothrips flaviantennatus Moulton, 1929, *Rec. Ind. Mus.* **31** : 98 ; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 45.

The present record is based on numerous females and males taken inside the leaf-rolls of a wild plant, Madras, 5.v.63.

Gynaikothrips fumipennis Karny

Gynaikothrips fumipennis Karny, 1913, *Bull. Jard. bot. Buitenzorg* **10** : 104-105.

This species is a new record for the Indian mainland, 8 females and 5 males collected from the leaf-rolls of *Conocephalus* sp. from Courtallum, 18.viii.1963.

Gynaikothrips karnyi Bagnall

Gynaikothrips karnyi Bagnall, 1913, *A.M.N.H.* **13** (8) : 23-31 ; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 46 ; Ananthakrishnan, 1952, *Indian J. Ent.* **14** : 201 ; Ananthakrishnan, 1960, *J. Bombay nat. Hist. Soc.* **57** (3) : 576.

This species causes the marginal-leaf-stitch gall in pepper (*Piper nigrum*) and is known all over south India. It was collected in the course of the present studies from Kallar, Burliar (Nilgiris), Calicut, Wynaad, Taliparamba, etc. (Kerala). Ananthakrishnan (1960) provides a complete range of variations of the males and females of this species. In so far as the present collections go, only the above species has been noticed within the gall.

Material. Numerous males and females inside pepper galls.

Gynaikothrips malabaricus Ramakrishna (Plate III, 10)

Gynaikothrips malabaricus Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7) : 302-303 ; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 46.

This species was described by Ramakrishna from 4 females and 3 males taken from the rolled tubular edges of *Ficus bengalensis*. More than 120 individuals were taken within similar *Ficus* galls from Yercaud (Salem) and Guindy, Madras.

Gynaikothrips moultoni Ramakrishna (Plate III, 8)

Gynaikothrips moultoni Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7): 303-304; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25**: 46; Ananthakrishnan, 1964, *Entomol. Ts. Arg.* 85. H 3-4: 225-226.

This species is known to produce tubular galls of *Ficus* sp. jutting out from the lower and upper leaf surfaces more or less similar to the horn galls. 45 females and 14 males were collected within such galls from Salem, 18.vii.1963.

Gynaikothrips pallicrus Karny

Gynaikothrips pallicrus Karny, 1923, *Treubia* **3**: 315; Ramakrishna & Margabandhu, 1939, *Rec. Ind. Mus.* **41**: 32.

While the host plant from which this species was collected by Ramakrishna & Margabandhu from the Nilgiris has not been mentioned, it is of interest to record 4 females and 2 males of this species from the leaf-galls of *Pothos scandens*, along with the gall-maker *Tetradothrips foliiperda* (Karny) and the inquiline *Mesothrips melinocnemis* Karny. Moodbidri, near Mangalore (Mysore State) 21.i.1964.

Gynaikothrips uzeli Zimmerman (Plate V, 14)

Gynaikothrips uzeli Zimmerman, 1900, *Bull. Inst. Bot. Buit.* **7**: 12.

This is one of the commonest species of *Gynaikothrips* producing leaf-fold galls on *Ficus benjamina*. Collections were made from identical galls from Burliar (Nilgiris) 7.vi.63, Courtallum (Tirunelveli District) 17.viii.63, and Agambe Forest, Mysore, 23.i.64; 23.i.65.

Gynaikothrips gracilis Karny

Gynaikothrips gracilis Karny, 1913, *Bull. Jard. bot. Buitenzorg* **10**: 113-115.

This species is found always in association with *Cercothrips nigrodentatus* on the leaves of *Planchona valida*. About 7 to 12 individuals on an average are present on a leaf. Localities, as for *C. nigrodentatus*.

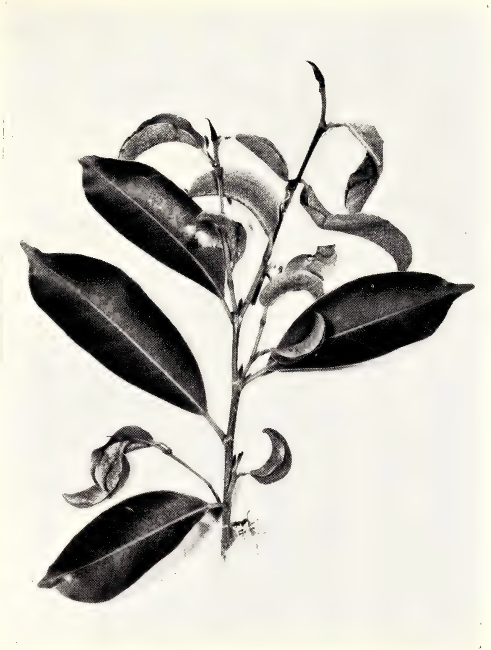
Liothrips hradecensis Uzel

Liothrips hradecensis Uzel, 1895, *Mon. Thys. Taff* **7**: 262.

Examination of *Ficus benjamina* galls for *G. uzeli* revealed the presence in very small numbers of the above species, which incidentally is an inquiline and a new record for India.

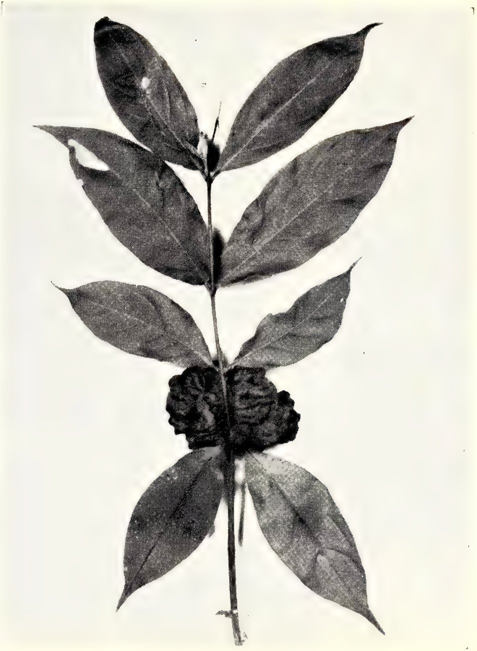
PLATE V

Gall-inhabiting Tubuliferous Thysanoptera



14

14. *Gynaikothrips uzeli*

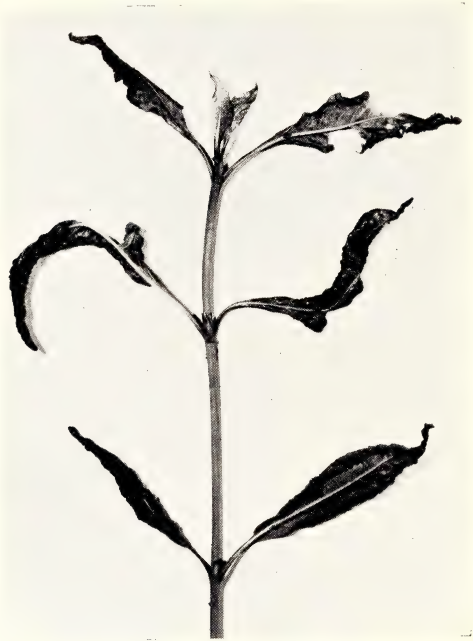


15

15. *Austrothrips cochinchinensis*

(*Photos : T. N. Ananthakrishnan*)

Gall-inhabiting Tubuliferous Thysanoptera



16. *Teuchothrips longus*

(*Photo : T. N. Ananthakrishnan*)

Material. Courtallum, 5 females inside *Ficus* galls along with *G. uzeli* and *Androthrips flavipes*, 13.x.64.

Lygothrips jambuvasi (Ramakrishna) (Plate II, 6)

Eothrips jambuvasi Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7) : 300-301.

Lygothrips jambuvasi Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 60-61.

Several individuals of both sexes of this interesting gall-maker were taken from leaf-margin galls of some wild species of *Eugenia*, Kodaikanal Hills, 2500 ft., 9.xii.1963. The following are the ranges of measurements of the females :

		FEMALE	MALE
Postoculars	..	38-48	22-26
Anteroangulars	..	13-19	—
Midlaterals	..	13-22	13
Postangulars	..	45-64	45-51
Epimerals	..	45-64	45-51

Mallothrips indicus Ramakrishna (Plate II, 7)

Mallothrips indicus Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7) : 308 ; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 50 ; Priesner, 1949, *Bull. Soc. Fouad Ier Entom.* **33** : 91, 93 ; Ananthakrishnan 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 63-65.

This species was hitherto believed to make the galls on *Eugenia jambolana* leaves. As the accompanying plate shows, the galls are in the form of several isolated oval brownish patches on the leaf. When these become dry with cracks on the surface, individuals (adults) of this species enter the galls. No nymphal stages are met with within the gall, the actual producer of which is some psyllid species. Ananthakrishnan (1964) gives an account of the range of variation of the species.

Material. 20 females, 6 males, 10.vii.63 ; 14 females, 5 males, Pondicherry, 24.vii.63 ; 28 females, 8 males, Tirupathi, 26.vii.65.

Mesothrips melinocnemis Karny

Mesothrips melinocnemis Karny, 1926, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **9** (6) : 229 ; Ramakrishna, 1928, ibid. **10** (7) : 307 ; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25** : 49.

This species is found in association with *Tetradothrips foliiperda* within the leaf-galls of *Pothos scandens* (Plate I, 3). The material under review is based on a collection of these species collected from these galls in Moodbidri (Mangalore) and Taliparamba (Kerala).

From the meagre number of individuals collected within a large number of galls, this species has to be regarded only as an intruder on the real gall-maker, *Tetradothrips foliiperda*, which was found in considerable numbers. Postoculars 128 to 140; anteroangulars and anteromarginals and midlaterals almost subequal, short, 38 to 48 long; postangulars 128 to 144 and epimerals 128 to 147 long. Accessory fringes of forewing, 6 to 9.

Material. 2 females and 1 male, Mangalore, 20.i.1964.

Mesothrips jordani Zimmerman

Mesothrips jordani Zimmerman, 1900, *Bull. Inst. bot. Buitenzorg* 7 : 16; Karny, 1912, *Marcellia* **11** : 148; Karny & Vanleeuwen, 1913, *Bull. Inst. bot. Buitenzorg* **10** : 68-69.

This species is also a new record for the Indian mainland. It is found in the company of *Gynaikothrips uzeli.* Twelve individuals (7 females and 5 males) were collected from leaf-galls of *Ficus* sp., Courtallum, 18.viii.63.

Anteroangulars 32 to 64; anteromarginals 32 to 48; postangulars 53 to 64; and epimerals 80 to 112, all dark, strong, almost pointed; accessory fringes of forewings 11 to 16. The forefemoral width in the males varies from 112 to 280 in the oedymerous forms.

Mesothrips vitripennis Karny (Plate IV, 12)

Mesothrips vitripennis Karny, 1923, *Jour. Siam. Soc.* **16** (2) : 149; Priesner, 1926, *Treubia* **8**, Suppl. : 109; Priesner, 1929 ibid. **10** (4) : 452, 458, 460.

This species also is a new record for the Indian mainland. Several individuals were collected from the leaf-roll galls of *Anogeissus* (Combretacea) from Courtallum and Kerala.

Prothoracic chaetotaxy. Females: Postoculars 96 to 112, anteroangulars 64 to 73, anteromarginals 48, midlaterals 105, epimerals 96, double fringes on forewing 7 to 11.

Material. 32 females, 12 males, Courtallum, 17.viii.63; 7 females, 2 males, Wynaad, 14.xi.63.

Rhynchothrips raoensis Ramakrishna

Rhynchothrips raoensis Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7) : 282.

14 females and 6 males of this species were collected from the leaf-galls of *Mallotus philippinensis* from Courtallum, 17.viii.63.

Tetradothrips foliiperda (Karny) (Plate I, 3)

Eothrips foliiperda Karny, 1926, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **9** (6): 222; Ramakrishna, 1928, ibid. **10** (7): 298.

Tetradothrips foliiperda Priesner, 1952, *Indian J. Ent.* **12** (2): 98; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25** : 40.

This species causes the leaf-roll gall in *Pothos scandens.* Of over 40 adults taken, only 3 or 4 individuals of *Mesothrips melinocnemis* Karny were noticed.

Postoculars 35 to 48 long; anteroangulars, anteromarginals, and midlaterals, very short, pointed, 35 to 38 long; postangulars 144 to 166 and epimerals 176 to 198 long.

Material. 26 females and 12 males within leaf-galls of *Pothos scandens*, Moodbidri, Mangalore (20.i.1964).

Teuchothrips longus (Schmutz) (Plate VI, 16)

Mesothrips longus Schmutz, 1913, *Sitz. Akad. Wiss. Wien* **122** (1) : 1054.

The species appears to be a common gall-former, causing marginal leaf-roll galls of *Pavetta* sp. Only two species of gall-making *Teuchothrips* are known from this country, *T. priesneri* Ananthakrishnan being the other species.

Prothoracic chaetotaxy. Females : Postoculars 64 to 70 long, anteroangulars 32 to 48; anteromarginals 26 to 38; midlaterals 43 to 54; postangulars 64 to 80 and epimerals 70 to 93; all setae dilate at apex; 5 to 8 double fringes on forewings.

Material. 34 females, 30 males on leaf-galls of *Pavetta* sp., Courtallum, 18.viii.63; 25 females, 10 males on leaf-galls of *Pavetta* sp., Omalur, Salem, 23.iii.64; numerous males and females, Alagarkoil (Madura), 15.x.64.

Teuchothrips priesneri Ananthakrishnan (Plate III, 11)

Teuchothrips priesneri Ananthakrishnan, 1964, *Entomol. Ts. Arg.* 85. H 3-4 : 234-235.

This is a stout built species of *Teuchothrips* causing complete leaf-gall of the terminal leaf of the tree. Several individuals, adult and larvae, seen inside the gall, which in its final stages of development appears twisted and crumpled.

Prothoracic chaetotaxy. Females : Postoculars 106 to 112 long, pointed; anteroangulars 43 to 51; anteromarginals 43 to 48; midlaterals 70 to 80; postangulars 160 to 166, and epimerals 131 to 160 long, all pointed. Forewings with 26 to 29 double fringes. The macropterous females are 3·444-3·808 mm. long, while the males are 3·570-3·710 mm. long.

Thilakothrips babuli Ramakrishna (Plate I, 1)

Thilakothrips babuli Ramakrishna, 1928, *Mem. Dept. Agr. Ind., Ent. Ser., Calcutta* **10** (7): 275; Ramakrishna & Margabandhu, 1940, *Catalogue of Indian Insects* **25**: 30; Priesner, 1949, *Bull. Soc. Fouad Ier Entom.* **33**: 67; Hood, 1957, *Proc. Ent. Soc. Wash.* **59** (4): 194-197; Ananthakrishnan, 1964, *Opuscula Entomologica Lund. Suppl.* **25**: 80-81.

Over 170 individuals of this remarkable gall-maker were recently collected from Kolattur, Chingleput District, making the leaf rosettes on *Acacia leucophloea.*

Macropterous and brachypterous individuals were found, the range of variations being: Macropterous females—Postoculars 38 to 51, anteroangulars 38 to 51, anteromarginals 38 to 51, postangulars 43 to 48, epimerals 64 to 80, accessory epimerals 32 to 48; males: 32 to 45, 29 to 32, 19 to 32, 42 to 48, 51 to 67, 32 to 38 respectively.

This species has been collected subsequently from Secunderabad, Gudur, and Tirupathi in Andhra Pradesh.

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Further contribution to the Flora of Pavagadh Hill near Baroda, Gujarat

BY

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ABSTRACT

In this paper twenty-six plants are listed, many of which are not reported by earlier workers from this area. *Cassia mimosoides* L. is reported here for the first time for Gujarat. The occurrence of *Argyreia sericea* Dalz. and *Cynoctonum mitreola* Britt. in the present area is an additional locality, since the former has been reported from Saurashtra by Santapau (1953) and the latter from Lunavada by Saxton (1922).

INTRODUCTION

The flora of many of the forests in the hilly regions of Gujarat State except for a few forests, e.g. Gir Forest (Santapau & Raizada 1955), Dangs Forest (Santapau 1954-55), and the forests of Pavagadh Hill, seems to be little known. Pavagadh Hill, about 46 km. NE. of Baroda, is botanically known to some extent by the work of Santapau (1955), Phatak & Joshi (1955), Phatak & Oza (1959), Chavan & Mehta (1959), and Chavan & Oza (1960, 1961, and 1963).

The authors visited this hill on 20.9.1964 on a botanical excursion, when extensive collections were made and ample field notes taken. During this outing some rare plants for Gujarat, e.g. *Acrocephalus indicus* O. Kuntze, *Argyreia sericea* Dalz., *Cassia mimosoides* L., *Cynoctonum mitreola* Britt., *Eriophorum comosum* Wall., *Ipomoea sindica* Stapf, etc., were collected. *Cassia mimosoides* L., which is fairly common in the vicinity of Bombay, was collected here for the first time in Gujarat. *Striga gesneroides* Vatke, a root parasite commonly found on *Lepidagathis cuspidata* Nees, was noted on *L. trinervis* Wall. ex Nees. Its occurrence on the latter host has also been reported by Santapau (1960, p. 162). The flowering of *Carvia callosa* Bremek. (=*Strobilanthes callosus* Wall.) has been discussed by Santapau (1944, 1950, 1952, 1962). We also found it flowering profusely and it was one of the conspicuous plants at this time.

Most of the plants listed here are not reported by earlier workers in the area. Some plants, already accounted for in earlier works, have also been included, as our observations are somewhat different from those published.

The names of most of the plants in the present list are the same as those given in Cooke's FLORA (1958); where the name is changed, the correct name (according to us) is given first, followed by the name in Cooke's FLORA as a synonym. At the end of each item, we give our collection number. All the sheets collected from Pavagadh are deposited in the Herbarium of the Department of Botany, Sardar Vallabhbhai Vidyapeeth, Vallabh Vidyanagar. Our identifications have been confirmed by matching the sheets of plants listed with those in the Blatter Herbarium, St. Xavier's College, Bombay.

LIST OF PLANTS

MALVACEAE

1. **Abutilon ramosum** Guill. Perr. et. A. Rich.

Rare; in the undergrowth of forest at the foot of the hill. Flowers yellow. (*Shah* 11047).

TILIACEAE

2. **Triumfetta pentandra** A. Rich.

Occasional along roadsides and among grasses at the foot of the hill. For the correct identity of this plant see Blatter in *J. Bombay nat. Hist. Soc.* **34**: 890, 1931, and Vartak, ibid. **56** (2): 365-366, 1959. (*Shah* 11061)

LINACEAE

3. **Linum mysorense** Heyne

Small herbs, conspicuous by yellow flowers. Common among grasses. (*Shah* 11065)

PAPILIONACEAE

4. **Atylosia platycarpa** Benth.

Occasional among grasses. Flowers yellow. (*Shah* 11039)

5. **Desmodium diffusum** (L.) DC.

A few plants seen in the undergrowth of forest at the foot of the hill. Flowers bright purple. The glutinous viscid hairs are typical of this plant. (*Shah* 11059)

6. **Indigofera glandulosa** Roxb. ex Willd.

Occasional in moist ground along margins of a pond. (*Shah* 11076A)

CAESALPINIACEAE

7. **Cassia mimosoides** L.

Rare; a few plants seen among grasses at the foot of the hill. Flowers yellow. (*Shah* 11050)

RUBIACEAE

8. **Adina cordifolia** (Roxb.) Hook. f.

One tree seen near Machi. (*Shah* 11055)

COMPOSITAE

9. **Centratherum phyllolaenum** (DC.) Benth. ex Clarke

Common in shaded spots; also seen on old walls. (*Shah* 11058)

10. **Pulicaria wightiana** (DC.) Benth. ex Clarke

Occasional among grasses. Flowers bright yellow. (*Shah* 11064)

LOGANIACEAE

11. **Cynoctonum mitreola** (L.) Britt. [*Mitreola oldenlandioides* Wall.]

Rare; only two plants seen in the undergrowth of the forest at the foot of the hill. Flowers white. The senior author (1962) has discussed the nomenclature of the present plant. (*Shah* 11081)

CONVOLVULACEAE

12. **Argyreia sericea** Dalz.

A patch seen among grasses. Flowers bright purple. This is an additional record from Gujarat. In the vicinity of Bombay this is one of the commonest twiners during the rainy season. (*Shah* 11070)

13. **Cuscuta chinensis** Lamk.

A rare parasite noted on *Cassia tora* L. Flowers pale yellow or creamy-white. (*Shah* 11081A)

14. **Ipomoea eriocarpa** R. Br.

An occasional twiner among grasses. Flowers purple. For the nomenclature of this plant see van Ooststroom in *Fl. Males* 4 (4): 462, 1954. (*Shah* 11088)

15. **Ipomoea muricata** (L.) Jacq. [*Calonyction muricatum* Don]

A rare twiner. Flowers bright purple. The thickened pedicels of the fruits and muricated stem are typical of this plant. (*Shah* 11086)

16. **Ipomoea sepiaria** Roxb.

Common on hedges. Flowers white. Santapau (1955) also reported this colour for this plant in this area. In vicinity of Tuva, in Kaira District, white flowers have been observed by us. However, in the neighbourhood of Baroda, Broach, and Bombay, the flowers seen, so far, have been the normal pink to rosy purple colour. Verdcourt [*Kew Bull.* 15(1) : 7-8, 1961] has discussed the nomenclature of the present plant and according to him *I. sepiaria* Roxb. is correct and not *I. maxima* Don ex Sw. as given in some recent works. (*Shah* 11054)

17. **Ipomoea sindica** Stapf

Rare; a small patch seen among grasses mixed with *Atylosia platycarpa* Benth. Flowers pale yellow or creamy-white. (*Shah* 11077)

18. **Ipomoea sinensis** (Desr.) Choisy [*Ipomoea calycia* (Roxb.) Clarke]

A rare twiner in the area. Flowers creamy-white. We have followed Verdcourt, Fl. Trop. Africa (Convolv.) p. 101, 1963, for the nomenclature of this plant. (*Shah* 11082)

SCROPHULARIACEAE

19. **Striga gesneroides** (Willd.) Vatke [*Striga orobanchioides* Benth.]

A rare parasite on *Lepidagathis trinervis* Wall. Flowers bright purple. (*Shah* 11076)

LABIATAE

20. **Acrocephalus indicus** O. Kuntze [*Acrocephalus capitatus* Benth.]

Rare on grassy slopes, growing along with *Lepidagathis trinervis* Wall. Flowers blue. (*Shah* 11078)

AMARANTHACEAE

21. **Achyranthes aspera** L. var. **porphyristachya** Hook. f.

Common in shaded spots. At the foot of the hill it was found among grass in patches mixed with *Pupalia lappacea* Juss. and *P. atropurpurea* Moq. (*Shah* 11048)

22. **Pupalia atropurpurea** (DC.) Moq.

Occasional among grass in stony ground. Spikes tinged bright purple. (*Shah* 11042)

EUPHORBIACEAE

23. **Phyllanthus urinaria** L.

Rare; the minutely echinate fruits are typical of this plant. (*Shah* 11095)

DIOSCOREACEAE

24. **Dioscorea pentaphylla** L.

Occasional twiner with female flowers and young fruits. (*Shah* 11105)

COMMELINACEAE

25. **Commelina kurzii** Clarke

A few plants noted on old walls. Flowers violet purple. This plant may be confused with *C. paludosa* Bl. (= *C. obliqua* Ham. ex Don) which it resembles in general appearance, but Rao (1962) has shown that the two species are quite distinct. Our plant tallies with the sheets of *C. kurzii* Clarke in the Blatter Herbarium, identified by Rao, and also with the illustration given by him. (*Shah* 11045)

CYPERACEAE

26. **Eriophorum comosum** Wall.

Rare, on grassy slopes. Cooke (3 : 411) cites locality Gujarat: *Champanir*, a village at the foot of Pavagadh Hill. (*Shah* 11063)

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On a new species of commensal porcellanid crab, *Polyonyx loimicola* sp. nov., from India: (Crustacea, Anomura, Porcellanidae)

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(*With two plates*)

The commensal porcellanid crab belonging to the genus *Polyonyx*, dealt with in another paper (Sankolli & Shenoy 1965) belongs to a hitherto undescribed species. The present paper deals with the taxonomic account of this new species.

Polyonyx loimicola sp. nov.

(Plates I and II)

Diagnosis. Carapace somewhat quadrangular, proportion of length to breadth being 3 : 4; dorsal surface strongly convex longitudinally, smooth with transverse rugae or plications on postero-lateral half behind the cardiac region; carapace regions faintly indicated, lateral margin fringed with matted hairs; front broad, measuring nearly $\frac{3}{4}$ the width of carapace and fringed with matted hairs between the eyes which are remarkably small; rostrum obtuse, scarcely produced; chelipeds unequal, provided with matted hairs; merus with fine transverse rugae on dorsal surface, its lobe slightly produced; carpus broadens distally, its dorsal surface almost smooth except for fine rugae proximally, its convex carina edged with granular bead-like tubercles; propodus with few rugae; fingers of major chela with a gap between them when closed, their tips bent slightly outwards, cutting edge of fixed finger with one big basal tooth and that of movable finger with about 6 teeth, the distal-most being the largest; all the segments of chelipeds matted with hair, merus on the inner surface, carpus thinly along the carina and the inner lower and distal margins, propodus densely matted with hair on the inner lateral surface and along the entire outer lower margin, the hairs spreading on the entire fixed finger ; finger gap and dactylus fringed with matted hairs ; fingers of smaller cheliped with a very little gap and cross each other when closed ; walking legs thickly matted with hair, merus and carpus unarmed, merus of 3rd leg twice as long as broad and propodus of the same leg more than twice as long as broad and armed with 3 distal spinules on posterior margin, no submedian spinule, dactylus four-clawed ; males with a single pair of pleopods.

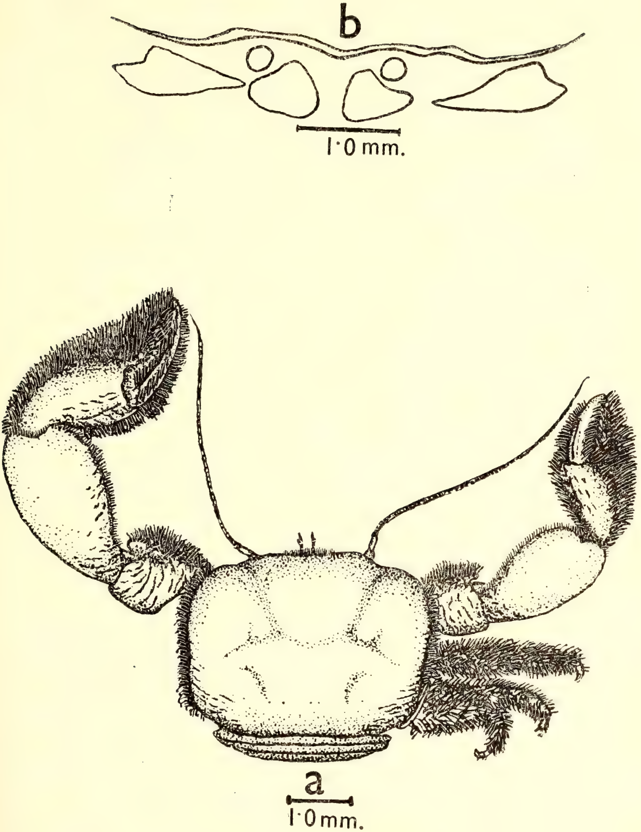
Description. Carapace (Plate I, a) broader than long, proportion of length to breadth being 3 : 4. Dorsal surface strongly convex longitudinally, smooth with transverse rugae or plications on the postero-lateral half behind the cardiac region. Carapace regions faintly indicated. The lateral margin of carapace is fringed with thickly matted hairs. Front broad, straight in dorsal view, measuring nearly $\frac{3}{4}$ the width of the carapace, and fringed with matted hairs between the eyes, which are remarkably small ; rostrum obtuse, projecting a little and not seen from above (Plate I, b). Antero-lateral margin of carapace takes a fine curve immediately after the base of antennal peduncle ; postero-lateral margin rounded ; posterior margin concave.

Antennule (Plate II, a). First segment smooth, thickened distally ; upper plate flat rather than concave ; antero-inner lobe not produced beyond upper plate ; lateral margins convergent basally.

Antenna (Plate II, b). The first segment broad, elongated, narrowing towards the inner side to an acuminate point. Remaining segments are cylindrical and smooth.

Third maxilliped (Plate II, c). Inner crest of merus rather narrow, though rounded and almost symmetrical ; sternum of third maxilliped shorter than the thoracic sternum (Plate II, d) and its anterior margin is convex. The lateral processes are long and narrow, slightly projecting upwards beyond the anterior margin with slightly concave outer lateral border.

Chelipeds (Plate I, a). Unequal, left or right being larger ; provided with matted hairs. Merus with fine transverse rugae which are most prominent on the dorsal surface and practically absent on the ventral surface. The distal end of the anterior margin so slightly produced that it can hardly be called a carina. Carpus twice as long as broad and much narrower proximally than distally, forming a convex carina on its anterior margin which is edged with granular bead-like tubercles. Dorsal surface smooth except for fine rugae which are present proximally and along the proximal half of the anterior margin. Propodus armed with few rugae, which are prominent about the upper inner side and fade away along the upper outer, inner lower, and ventral surfaces, and towards the fixed finger. The fingers of the major chela leave a gap between them when closed and their tips are bent slightly outwards. Dactylus has one or two longitudinal plications which run almost


b
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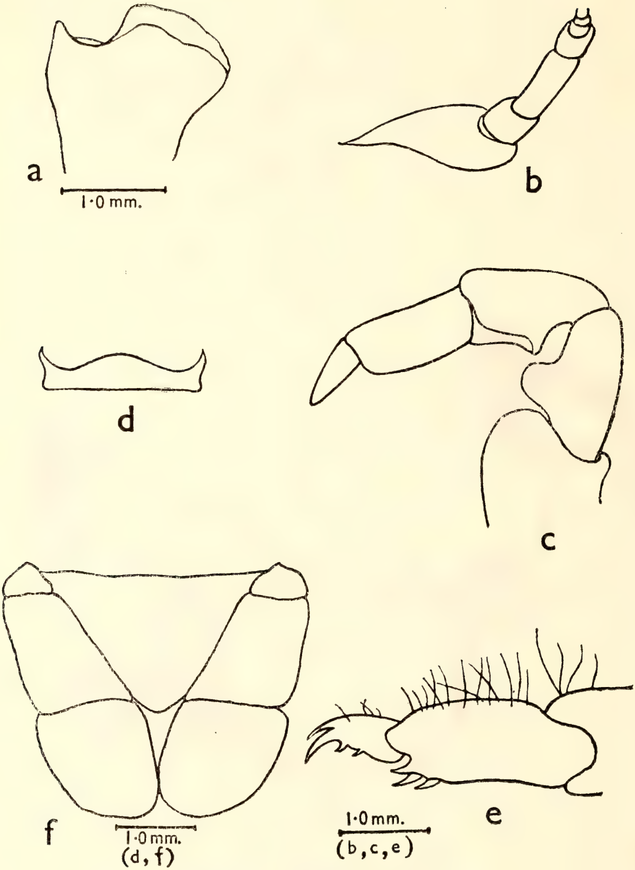
Polyonyx loimicola sp. nov.

a. Dorsal view; *b.* front as viewed from above


a
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(d, f)
1·0 mm.
(b, c, e)
e

Polyonyx loimicola sp. nov.

a. Basal segment of antennule ; *b*. antenna ; *c*. third maxilliped ; *d*. sternum of third maxilliped ; *e*. third leg ; *f*. telson parallel to its anterior margin. All the segments of chelipeds matted with hair, merus on inner surface and carpus thinly along the carina and along the inner lower and distal margins ; propodus densely matted with hair along the entire outer lower margin. These hairs also spread on the entire fixed finger starting from about its base ; so also on inner lateral surface of propodus and the finger gap. Dactylus is also fringed with matted hairs. Cutting edge of fixed finger is armed with one big tubercle-like tooth basally and that of the movable finger with six teeth of which the first (basal), fifth, and sixth (distal-most) are longer than the remaining three which are closely set. The distal-most tooth, the largest, is situated slightly ventrally.

Smaller cheliped differs from the major in that the fingers leave very little gap between them and cross each other when closed.

Ambulatory leg (Plate II, e). These successively decrease in size, bearing thickly matted hairs all over except the anterior part of ventral surface, on dactylus hairs are scanty ; merus and carpus unarmed ; merus of third walking leg about twice as long as wide, and the propodus more than twice as long as wide and armed with 3 spinules on posterior margin, 2 of which are in a pair at the distal end and the 3rd just behind them ; dactylus 4-clawed, the accessory claw being smaller than the principal which is the largest, the remaining 2 being very small.

Telson (Plate II, f). 7-plated, the central plate being rather broad.

Male. A pair of pleopods occur in the males.

Material examined. About 50 specimens of varying sizes were collected from Chowpatty, Bombay.

Holotype (:) a ♀ which will, in due course, be deposited in the collection of the Zoological Survey of India, Calcutta.

Measurements. Of the material examined, males ranged from 3·0 to 6·5 mm., non-ovigerous females from 3·00 to 4·25 mm., and ovigerous females from 4·25 to 8·50 mm., in carapace width.

Colour in life. The crabs are light brown in colour, matching well with the inner side of the tube of *Loimia medusa*, the host organism.

Ecology. This species is a commensal of the Annelid tube-worm *Loimia medusa* (Savigny) which is quite common in the intertidal zone. Generally a pair of crabs, male and female, is found inside the tube of the host, the size of the crabs varying with that of the tube. In a pair, the female is usually larger than the male.

Ovigerous females were collected throughout the year except during the monsoon (from June to September) when observations could not be made.

Relationship. The new species belongs to the *P. sinensis* group as defined by Johnson (1958) for the Indo-West Pacific species of *Polyonyx*. Of this group, *P. utinomi* Miyake, *P. sinensis* Stimpson, and *P. cometes* Walker, especially the last two, are more closely related to the new species. The salient morphological features of these three and the new species are given in Table at pp. 290-1 below.

P. utinomi, which is also a commensal form (Miyake 1943), differs in having the lateral margins of the carapace not hairy ; only inner surface of carpus and merus of the chelipeds somewhat hairy ; meral lobe large ; carpus not broadening distally ; no tooth at the base of the cutting edge of fingers of the major cheliped.

As regards *P. sinensis*, the only available information is Stimpson's (1858) very short, rather inadequate description and figure, supposed to be based largely on a male (as cited by Johnson 1958). Shen (1936) redescribed this species but under a different name, *asiaticus*, based on a single ovigerous female, and later Miyake (1943) described a single male as *sinensis*. Miyake, however, does not compare it with Shen's *asiaticus*. My comparison of the new species with the description of *sinensis* as given by Shen and Miyake shows the following differences from the new species : chelipeds and walking legs much less hairy, i.e. mostly in the form of a marginal fringe ; the cutting edge of dactylus of major cheliped with not more than a single, blunt tooth at the base ; fingers of smaller cheliped not gaping ; a sub-median spinule on the lower border of propodus of walking legs, in addition to the 3 distal ones.

Johnson (1958) placed de Man's (1888) *euphrosyne* as a synonym of Walker's (1887) *cometes*. His conclusions were based on a comparison of the descriptions and figures as given by the two authors. But Johnson's statement that de Man's material came from the siphons of the bivalve *Aspergillum* is incorrect. De Man, in his account of the species clearly stated : ' A fine, adult specimen without eggs was found by Dr. Anderson, living along with an annelid in its tube ', and commented on the similar commensal habits of this species and Haswell's *P. transversus*, which was found in the siphons of *Aspergillum*. *P. cometes* differs from the new species in the following characters : carpus of major cheliped somewhat different in shape and almost uniformly broad except for the narrowing at either extremity (as per de Man's figure) ; a prominent meral lobe ; a sub-median spinule on the posterior margin of propodus of walking legs ; no tooth at the base of the cutting edge of fixed finger ; upper surface of carpus and outer surface of palm minutely punctate in major cheliped.

Remarks. Some of the specimens are comparatively less hairy on the sides of the carapace and on the carpus and merus of the chelipeds.

The present account brings the total number of *Polyonyx* spp. known from the Indo-West Pacific region to 16, 14 recognized by Johnson (1958) and another new species, described by me (Sankolli *in the press*).

ACKNOWLEDGEMENTS

I am greatly obliged to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra, for critically going through the manuscript, and to Dr. H. G. Kewalramani, Senior Scientific Officer, for valuable guidance during the course of the study. I am specially indebted to Dr. (Miss) Janet Haig of Allan Hancock Foundation, California, for confirming the new species, for providing a photo-copy of Shen's (1936) paper, and for valuable suggestions.

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TABLE

SALIENT MORPHOLOGICAL FEATURES OF THE FOUR SPECIES OF *Polyonyx*

Characters	*P. loimicola* sp. nov.	*P. utinomi* Miyake	*P. sinensis* Stimpson (as per Miyake and Shen)	*P. cometes* Walker (as per de Man)
Carapace 1. Front	Frontal lobe scarcely produced	Frontal lobe scarcely produced	Frontal lobe scarcely produced	Frontal lobe scarcely produced
2. Dorsal surface	Smooth with transverse rugae or plications on postero-lateral half behind the cardiac region	Smooth, glabrous, and with transverse lines near the lateral margins	Smooth, glabrous to the naked eye, but near the lateral margin with transverse lineolation visible under lens	Smooth and glabrous
3. Lateral margin	Fringed with thickly matted hairs	Not hairy	Not hairy	Extremely hairy
Major cheliped	Merus to dactylus with matted hairs, more dense on propod; fine, transverse rugae, more prominent on merus and few on carpus and propod	Only propod with a line of thick hair on lower margin; merus to propod with delicate, transverse lines on upper surface	Much less hairy, i.e. in the form of a marginal fringe; surface smooth and glabrous	Merus to propod extremely hairy; but upper surface of merus with microscopic transverse lines distally; carpus minutely punctate on upper surface but palm on outer surface only
Merus	Very slightly produced meral lobe	Large meral lobe	Meral lobe absent	Very prominent but minutely denticulate meral lobe
Carpus	Broadens distally and very narrow proximally, its carinate anterior margin convex and edged with granular bead-like tubercles	Rather not broadening distally; its carinate anterior margin almost straight and smooth	Elongated, broadest distally but not very narrow proximally; its carinate anterior margin smooth, convex in its distal half	Almost uniformly broad except at either extremity where it is rather narrow; its carinate anterior margin smooth and slightly convex

TABLE—(*continued*)

SALIENT MORPHOLOGICAL FEATURES OF THE FOUR SPECIES OF *Polyonyx*

Characters	*P. loimicola* sp. nov.	*P. utinomi* Miyake	*P. sinensis* Stimpson (as per Miyake and Shen)	*P. cometes* Walker (as per de Man)
Fingers	Gaping, tips slightly bent outwards; cutting edge of fixed finger with one big tubercle-like basal tooth and that of movable finger with about 6 teeth, the distal-most being the largest	Twisted; cutting edge of both fingers armed with small teeth but no large tooth at the base of the cutting edge	Gaping, much twisted; fixed finger armed with a basal tooth; movable finger with not more than a single, blunt tooth at the base	Gaping (de Man's fig. 3, pl. 15, 1888) with arcuated, pointed tips, crossing one another slightly; no large tooth at the base of the cutting edge of the fixed finger though the outer border of the edge is faintly crenulate with the small prominence beyond the middle; outer border of cutting edge of movable finger crenulate and with a small, transverse tooth at the base
Walking legs	Densely hairy	As per Miyake's figure, slightly hairy	Much less hairy, i.e. in form of marginal fringe	Densely hairy
Merus	Unarmed ventrally; that of 3rd leg twice as long as broad	Unarmed ventrally; that of 3rd leg twice as long as broad	Unarmed ventrally; that of 3rd leg twice as long as broad	Unarmed ventrally; that of 3rd leg twice as long as broad
Propodus	3 distal spinules on posterior margin, no submedian spinule	3 distal spinules on posterior margin, no submedian spinule	In addition to 3 distal spinules, a submedian spinule also present	In addition to 3 distal, a submedian spinule also present
Dactylus	4-clawed (2 big + 2 small)	4-clawed (2 big + 2 small)	As per Shen 4-clawed (2 large + 2 small) and as per Miyake 5-clawed (1 principal + 2 accessory + 2 small)	4-clawed (2 big + 2 small)

Reviews

1. THE BIRDS OF THE PALAEARCTIC FAUNA. Non-Passeriformes. By Charles Vaurie. pp. xx + 763 (25·5 × 18·5 cm.). H. F. & G. Witherby Ltd., London, 1965. Price £7. 7*s*.

The first volume of this monumental work was reviewed in an earlier number of the *Journal* (Vol. **56**, pp. 307-9). There is perhaps no ornithological institution or scientific ornithologist—more especially one concerned with the Old World—who has not had constant recourse to that volume since its publication in 1959. As predicted by the reviewer and others, it has proved truly indispensable, and the measure of its excellence and authoritativeness is the remarkable degree of acceptance which Dr. Vaurie's views and dicta have by and large received from his scientific colleagues throughout the world.

This second volume dealing with the non-passerine birds brings to a conclusion the ambitious task upon which Dr. Vaurie had embarked, namely bringing up-to-date the knowledge of the geographical distribution of palaearctic birds and stream-lining the taxonomy in Ernst Hartert's DIE VÖGEL DER PALÄARKTISCHEN FAUNA with modern concepts. Like the previous volume this one also is based on the author's own critical studies of the wealth of material in the American Museum of Natural History, New York, the bulk of which formed the basis of Hartert's classic at Tring before it was sold by its owner, Lord Rothschild, to the American Museum and transferred across the Atlantic. That collection has since been vastly augmented by further acquisitions over the years. In addition to all this, Dr. Vaurie had opportunities to study relevant material in most of the great museums of the world, including those in the USSR, by personal visits to these institutions or by large-scale borrowings from them. His discussion of problems with leading ornithologists and with specialists in various groups of non-passerine birds fortified his views and has helped to add further authoritativeness to the present work.

Dr. Vaurie's taxonomic observations and findings, accruing as his studies progressed, were published from time to time as 'Systematic Notes on Palaearctic Birds' in *American Museum Novitates* in twenty serial numbers (34-53). These are, in fact, comprehensive reviews and, in part, revisions of the various groups summarized in this volume. They form a very important adjunct to it and furnish invaluable references. It is good, therefore, to know that a separate synopsis and a complete index to this series are in course of preparation.

The selected bibliography comprising some more recent general works, check-lists, and regional books and papers bearing on the Palaearctic Region forms a useful supplement to the bibliography given in Vol. 1. This is followed, as before, by indices of English, French, German, and Scientific names.

In congratulating Dr. Vaurie upon his herculean achievement ornithologists will not omit to congratulate themselves upon the availability in this handy form of the wealth of carefully sifted first-hand information, more particularly from the USSR which is usually denied to most of us by inability to benefit from publications in the Russian language.

The coverage of the volume—16 Orders, 46 Families many of them divided into Subfamilies, 192 Genera with their spate of species and subspecies—indicates the stupendous labour that has gone into its making. The re-examination of this vast material and all but a few of the measurements were made by the author himself.

There can be no complete finality in a work of this sort. Nevertheless, it does not seem rash to predict that these volumes will dominate the field of palaearctic ornithology for as long as one can see, and thereafter still continue to remain as indispensable as Hartert's masterpiece is today.

S. A.

2. SEASIDE PLANTS OF THE WORLD. By Edwin A. Menninger, D. SC. pp. 303 (23 × 16 cm.). With 408 photographs. New York, 1964. Hearthside Press Incorporated. Price $ 9.95.

The sub-title informs us that this book is meant to be a guide to the planning, planting, and maintenance of salt-resistant gardens. As a nurseryman who has for years catered for owners of seaside gardens the author is well equipped to undertake the task; he has taken freely, besides, of the experience of other gardeners.

The first problem of the seaside gardener, protection against salt, sand, and sea, is dealt with generally in the opening chapters. These include a chapter of wider applicability, on erosion and reclamation—it is interesting to learn that as far back as 1307 a sea-weed (*Ammophila arenaria*) was successfully used to halt shifting sand-dunes. This introduction is followed appropriately by a list of plants suitable for ground cover. They are arranged according to their toughness, those capable of standing full exposure to the sea as on the beach (Belt I), those requiring a little protection (Belt II), those requiring much protection (Belt III). This arrangement, according to suitability for the three different belts, is followed in the subsequent chapters, which deal in turn with Vines, Grass and Lily-like Plants, Herbs and Sub-shrubs, Shrubs for Seaside Landscaping, Trees, and Palms. There is a certain amount of overlapping as it was not possible, nor would it have made for convenience, to make a rigid distribution between these several groups. The final chapter gives a short account of the way in which these problems are dealt with in Australia and New Zealand, countries in which there is a long length of sea-coast, an enormous wealth of native salt-resistant plants, and wide variations in climatic conditions. Short descriptions are given of the plants listed and many of them are illustrated by photographs, to give laymen an idea of their appearance and to help with their identification. There are also numerous landscape photographs to show what can be done by skilful gardening.

It is common knowledge that, given suitable conditions, plants that are natives of one country will readily grow in another, and sometimes will even do well in a country with a different climate. So, this list of 2000 plants or more deriving from all the continents will be of use to the gardener, wherever he may be. But he must be prepared to face occasional disappointment, for it is not possible to know all the factors that contribute to the successful growth of a particular plant and it is only by actual experiment that he can find out how it will behave in his garden. For the gardener who has known the joy of successful experimenting the fear of disappointment can be no deterrent, and it is to such that the book is recommended.

Of interest to the general reader is a citation of an observation of R. W. Read, botanist at the Fairchild Tropical Garden: 'There is evidently some correlation between an arid or xerophytic environment and a coastal or saline environment, for it has been frequently observed that many palms found naturally only in desert regions flourish along our sea coast. Some desert species even grow better in moist saline soils than in the drier non-saline limestone or sand soils of south Florida.'

A photograph from South Australia shows an expanse of sand about ten feet above high tide mark covered with flowering Arctotis (*A. stoechadifolia*). Another such photograph, also from South Australia, shows *Chrysanthemum frutescens* in flower. Looking at these photographs one cannot resist asking the question: 'If in South Australia, why not in India?' Who will make the experiment, or has this already been done?

D. E. R.

3. MAMMALS OF THE WORLD, Vols. I and II. By Ernest P. Walker and associates. Vol. I, pp. xlviii+646; Vol. II, pp. viii+647-1500 (26 × 18·5 cm.), numerous illustrations. Baltimore 1964. The Johns Hopkins Press. Price Vols. I and II $25·00.

The opening sentences of the Foreword, 'The content and scope of these volumes represent a unique and highly valuable contribution to zoological literature. There is no other single series of books that in themselves can be used as a basic source of reference concerning all the known and present genera of mammalian life on this earth', precisely express the scope and value of this publication. Mr. Walker and his associates are to be congratulated on the excellent result of their effort which in Mr. Walker's case involved nearly thirty years of devoted labour in collecting material from published literature, in correspondence with Mammalogists all over the world, and in the collection of photographs of representative animals of the genera discussed.

The genus, as containing a group of species with many common characters, has been chosen as the unit of description—a sensible arrangement, considering the impossibility of adequately describing the twelve to fifteen thousand species of known mammals. The two volumes describe 1044 genera, included under 125 families and 19 orders of living mammals. The text includes general remarks on the characters occurring (1) in all members of an Order, (2) in all members of a Family. Under each genus, the common and scientific names, number of species, range, measurement and weight, coloration, type of body covering, structural peculiarities, habits, food, gestation period, number of young in a litter, economic importance, and other known facts are mentioned. Each genus described is illustrated by a photograph or picture of a member species. The numerous photographs of shrivelled museum skins are an woeful indication of the lack of material on mammals. The reviewer hopes that in future editions these photographs will be replaced by sketches.

The first volume includes a selected bibliography on mammals and the third volume, which the reviewer did not have the opportunity to see, contains exclusively, we are told, a comprehensive, general bibliography of over 40,000 papers.

In an encyclopaedic work of this type, one can only comment on the 'familiar faces', in this instance the Oriental Fauna. The comprehensive information on each genus would be of value to mammalogists and others requiring information on the mammals of this region. One can safely assume that similar detailed information is available on mammals of other faunal regions. The description of the rarer genera includes the names of Institutions which have specimens. It is unfortunate that the authors were not aware of the presence in the Society's collections of genera like *Hesperoptenus*, *Tylonycteris*, and *Otomops*—the last mentioned represented by specimens of *O. wroughtoni*, a species discovered and described in 1913 and seen again only when these specimens were recovered in 1961 from the very cave from which the types were collected.

In a work of this magnitude it is not surprising if some errors creep in. I find for instance that the distributions of *Rhizomys pruinosus* and *R. sinensis* have been interchanged. A photograph of the Spiny Mouse, *Mus platythrix* illustrates the genus *Platacanthomys* and has been described in the legend as that of the Spiny Dormouse, *Platacanthomys lasiurus*. These errors, which do not seriously detract from the value of the publication, will no doubt be removed in the next edition.

J. C. D.

4. BIRDS OF PREY OF THE WORLD. By Mary Louise Grossman and John Hamlet. Photographs by Shelly Grossman. pp. 496 (32 × 24 cm.). London 1965. Cassel & Co. Ltd. Price £ 6. 6*s*.

This magnificent volume containing a long and comprehensive account of birds of prey of the world covers over 500 pages and includes some 1400 illustrations, 70 in colour, and 283 monochrome photographs.

It is divided into two main portions—the first a general account of the groups, the second a brief account of 289 species of hawks and 133 of owls.

The chapters of the first part deal with (a) their history through geologic times, (b) their many contacts with man including not only falconry but also their influence on art and literature since Babylonian and earlier days, (c) their general ecology and habits, (d) the details of structure which assist them in their hunting, and (e) their conservation.

This last chapter is of great interest and importance to us in India as we are passing through the initial stages of a problem which has not yet ended even in America. James Fergusson Lees in the Introduction says: 'Post-war prosperity (in Europe) has led to an enormous increase in gun licences and introduced a new element of irresponsibility. Many species have been hit hard by the use of organo-chlorine pesticides in agriculture . . . . '. The Bombay Wild Animals and Wild Birds Protection Act, 1951, the most advanced legislation of its kind in India, still lists birds of prey as 'vermin' and permits them to be killed in and out of season, with or without reason!

The second section deals with the many genera and species throughout the world. In spite of subspecific differences being ignored, this is a tremendous task and there are bound to be omissions and errors. We notice that in the maps indicating the distribution, the several harriers *Circus macrourus*, *cyaneus*, *pygargus*, and *cinereus*, are excluded from India, while that for the Greater Spotted Eagle restricts it to north-western India. Young Longbilled Vultures are said to be entirely dark below streaked conspicuously with buff, but in our experience they are similar to the parents.

Many interesting facts are recorded, e.g. Goshawks chasing rabbits on foot through brush (p. 251), *Pernis* walking and running on the ground with ease of a corvine or gallinaceous bird (p. 219), and Ospreys in North America breeding in dense colonies (p. 369).

Some of the colour photographs are the best I have ever seen, and so are some of the black-and-white. But the fact that a disproportionately large number of birds are shown in the actual act of killing their prey cannot but leave the impression that the photographs were taken under controlled and not natural conditions. The small number of pictures and information regarding Indian species is noticeable.

However, the whole work was certainly an enormous undertaking and, for the layman, is as nearly perfect as is possible.

H.A.

5. PLANT EMBRYOLOGY: A Symposium. pp. vi + 274 (25 × 16·5 cm.). Illustrated. New Delhi 1962. Council of Scientific & Industrial Research. Price Rs. 20, or 40*s*.

This excellent publication is the report of an all-India Symposium on Plant Embryology held under the auspices of the Biological Research Committee of the Council of Scientific and Industrial Research on 11-14 November 1960, at the Department of Botany, University of Delhi.

As Professor Maheshwari, Chairman of the Biological Research Committee and Convenor of the Symposium, has indicated in the preface, the CSIR has been giving much encouragement to the holding of symposia and scientific conferences. This symposium on Plant Embryology was graced by the presence of the Vice-Chancellor of Delhi University and the Director-General of the CSIR attended the Symposium. A list of the participants is not given.

Professor Maheshwari gave a review of the 'Past, Present and Future of Plant Embryology' (not included in this publication) and pointed out that, although the study of plant embryology began in India only about 30 years ago, it has already become one of the most well-developed branches of plant science in India.

During the symposium 29 papers were read in seven sessions presided over by seven of the foremost Indian workers in plant embryology. All these 29 papers, with relevant illustrations, and a short preface by the convenor form this published report.

On the last day of the Symposium a special session was held for a discussion of the advancement of teaching and research in plant embryology. In this session it was agreed that the time is ripe for the production of an exhaustive volume on the Systematic Embryology of Angiosperms on the lines of Schnarf's VERGLEICHENDE EMBRYOLOGIE DER ANGIOSPERMS or Metcalf & Chalk's ANATOMY OF DICOTYLEDONS AND MONOCOTYLEDONS. It was thought that if such a work can be written through the initiative of Indian botanists with the co-operation of colleagues abroad, it will be of great value all over the botanical world.

The papers reported here cover a wide range of topics—from a hypothesis (New approach on the Embryo of Monocotyledons) to new facts on ovarian pollination (in *Papaver* and *Eschscholzia*). They include information on *in vitro* cultures of nucelli and embryos (of *Citrus* and *Cuscuta*) and the formation of male gametes in the pollen tube of some crop plants besides several other interesting embryological features.

As the cover of this publication declares, it highlights the progress of plant embryology in India, to which the school of plant embryology at the University of Delhi has made very valuable contributions and established for itself a rightful place of pride. This publication is truly an essential compendium of researches in plant embryology. It is to be hoped that the other branches of botany will be similarly served by the Biological Research Committee of the CSIR by holding of symposia to encourage teachers and research workers.

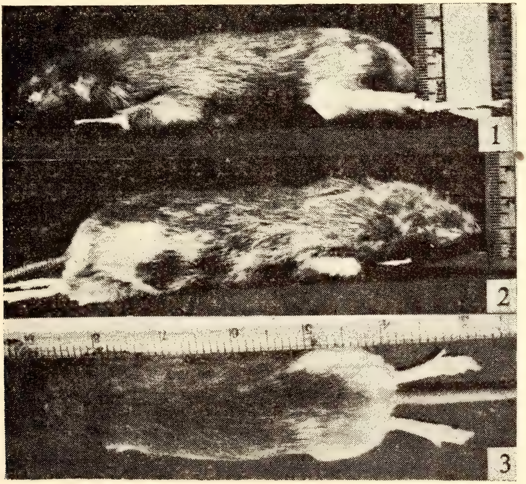
P. V. BOLE.

Miscellaneous Notes

1. PARTIAL ALBINISM IN WHITEBELLIED RAT, *RATTUS NIVIVENTER* HODGSON, FROM KHASI HILLS

(*With one photograph*)

Albinism is not uncommon in the genus *Rattus* Fischer, 1803. It is frequently met with in *Rattus rattus* Linnaeus, and has been recorded by Hossack (1907), Gibson-Hill (1950), and Harrison (1950). Gibson-Hill (1950) and Joshee & Kamath (1963) have reported it in *R. norvegicus* (Berkenhout). Harrison & Lim (1951) have recorded it in *R. cremoriventer* (Miller). So far as is known to us, albinism has not been recorded in *R. niviventer* Hodgson. Hence, the present case of partial albinism is considered worthy of record.



Partial albinism in *Rattus niviventer* Hodgson
1. Left side view; 2. Right side view; 3. Dorsal view

While identifying the rats of the Khasi Hills, where *Rattus niviventer mentosus* Thomas is quite common, we have come across a partial albino specimen of this race in a lot of 8 specimens collected from Shillong Peak.

The specimen is a male, measuring (in mm.) head and body 136, tail 190, ear 20, hind foot excluding claw 30.

The albinism occurs mainly on the posterior region and is found to some extent on the forelegs (Photo, Figs. 1 and 2). Normally, the pure white colour should be restricted to the belly up to the tip of the mouth ventrally and to the under surface of the feet and toes, but in this specimen it covers the whole right and left hindfeet with a sprinkling of normal brown-coloured hairs on each. The rump is pure white extending forward on both sides—on the right to nearly one-third of the head and body length and a little less on the left.

The normal mid-dorsal colour extends to the tail separating the white portions on both the sides (Photo, Fig. 3).

R. niviventer, according to Roonwal (1949), is essentially a rat of the dense evergreen jungle and riverain jungle, favouring the vicinity of hill-streams. The locality from which the present specimen was collected is also dense evergreen jungle far from human habitation. Thus it is unlikely that this instance of partial albinism is a result of the intermixing of domestic rat with *R. niviventer*.

ZOOLOGICAL SURVEY OF INDIA,
EASTERN REGIONAL STATION,
SHILLONG,
May 4, 1965.

A. S. RAJAGOPAL
A. K. MANDAL

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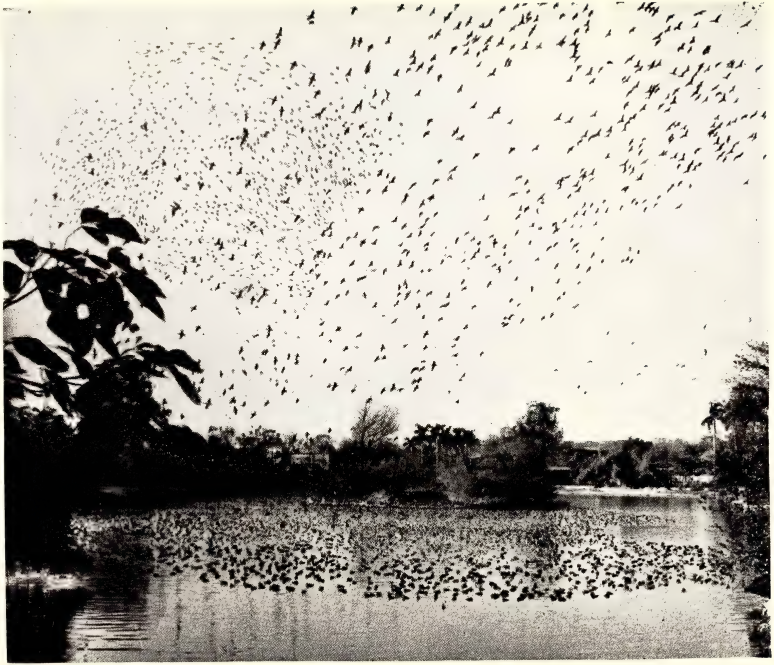
2. BEHAVIOUR OF LESSER WHISTLING TEAL [*DENDROCYGNA JAVANICA* (HORSFIELD)] IN ALIPORE ZOO, CALCUTTA

(*With a plate*)

On my way to the Andamans in February 1964, I was delayed for a few days in Calcutta. The Alipore Zoo is always an attraction and I spent some time very pleasantly there. The lake was full of Whistling Teal (*Dendrocygna javanica*), which spend the day here and leave at dusk to feed many miles away. This bird is too slow a flier to afford much



Lesser Whistling Teal (*Dendrocygna javanica*) in Alipore Zoo, Calcutta

(*Photo : Shyamadas Bose*)

sport, but is shot at by all and sundry. In the Gardens, they settled on the shore, less than 15 yards from where we sat and chatted. Mr. R. K. Lahiri, the very active Superintendent, sent some people round the lake, who put them up by banging tins and shouting. When all the birds were in the air, they literally filled the sky and reminded one of the duck shoots of the good old days. Mr. Lahiri said that he had made various attempts to estimate their numbers, and thought there were some 6000 birds. They returned to the lake after a few minutes and were soon settled in peace. Later when we were not paying any particular attention there was a gigantic splash on the lake. My first impression was that the birds had all risen again, but when we looked there were no birds in the air and only a few remained scattered here and there on the lake. It then dawned upon me that the birds in one part of the lake, say 50 yards by 100 yards, had all dived together. Lahiri said that this was a not unusual reaction to a bird of prey overhead, but none was visible. The teal soon reappeared and kept on opening their wings, probably to shake off the water. The simultaneousness of their dive was something to be seen to be believed. Other ducks take off the water as suddenly but, since they remain visible in the air, the effect is not so startling. In the evening, I saw flight after flight, 15 to 30 at a time, going over the city, mostly high up and out of gunshot. Outside the sanctuary, they are no tamer than elsewhere. Whistling Teal do migrate locally and their numbers at the Zoo are said to vary from time to time. This appears to be an excellent place where they could perhaps be captured and ringed.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 3,
February 23, 1965.

3. THE RED KITE *MILVUS MILVUS* (LINN.) IN ORISSA

A large flock of this species was repeatedly observed over several days by Sálim Ali (1954) during March 1945 on the Little Rann of Kutch. Shivrajkumar (1964) saw a single individual on 23.iii.64 in Saurashtra: We have similar evidence that its range extends to the east coast of India, at least in winter.

On 8.i.63 near the shore off Balugaon on Lake Chilka we saw a soaring kite which, by reference to Peterson *et al.* (1954) on the spot, we identified as *Milvus milvus*. We discovered from Ripley (1961) that this identification was unlikely. Neither of us had seen the species in any other country. On 19.i.64 we accompanied Dr. Bernhard Rensch to Puri where he recognized *M. milvus* with complete certainty, being familiar with it in Europe. He is of course familiar with living birds not only in India but in many other parts of Asia, and his certainty was unshaken by Ripley's statements.

GENETICS AND BIOMETRY LABORATORY,
GOVERNMENT OF ORISSA,
BHUBANESWAR-3,
February 23, 1965.

S. D. JAYAKAR
H. SPURWAY

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4. OCCURRENCE OF THE LONGTOED STINT *CALIDRIS SUBMINUTUS* (MIDDENDORFF) IN NORTH BIHAR

Three species of stint, our smallest wader, winter in India. Out of 145 stints collected in Monghyr District, north Bihar, for ringing between 23 November 1964 and 17 January 1965, 34 were Little Stints *Calidris minutus* (Leisler), 109 Temminck's Stints *C. temminckii* (Leisler), and 2 Longtoed Stints *C. subminutus* (Middendorff). The presence of the last is of particular interest as it has not been previously recorded from Bihar. The range of the Longtoed Stint as given in Ripley's SYNOPSIS (1961) is: 'On winter migration, occurs in Assam, East Pakistan and Ceylon'. The present record represents a westward extension of the winter distribution of this eastern Palaearctic breeder. The measurements (in mm.) of the specimen preserved, in the Society's collection bearing Register No. BNHS 22181, are: wing 89; tail 35; bill (from the skull) 21; middle toe 23.

In the hand, the Longtoed Stint can be easily distinguished from the other two by its long middle toe, 22·5 to 25 mm., while in others it is less than 20 mm. The middle toe with claw is longer than the tarsus in *subminutus* while in *minutus* and *temminckii* it is more or less equal. *Subminutus* also has a longer hindtoe (5 to 6 mm.) which in *temminckii* and *minutus* is shorter (3 to 4 mm.).

BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY, 1-BR,
June 10, 1965.

P. V. GEORGE,
Research Fellow

5. THE ASHY MINIVET [*PERICROCOTUS DIVARICATUS* (RAFFLES)] : AN ADDITION TO THE INDIAN AVIFAUNA]

On 31 January 1965, while collecting birds at Funnel Hill about an hour's drive from Bombay, I came across a mixed party of warblers and flycatchers in a rather thick patch of forest. Among them was a pair of unfamiliar birds calling to each other. They looked more like one of the white wagtails. Their calls were quite unfamiliar, resembling the harsh voice of a shrike rather than the melodious and pleasant trilling call of minivets.

A specimen was secured and the first impression was that it might be one of the Pied Shrikes of the genus *Hemipus*. Later, in the evening along with Mr. Pereira of the Society, I saw two more pairs of the same birds just at the foot of Funnel Hill. On further examination of the specimen collected, I came to the conclusion that it was an Ashy Minivet, *Pericrocotus divaricatus*, an opinion which was confirmed by study of literature available at the Bombay Natural History Society. The species is not listed is Ripley's SYNOPSIS. The distribution given in the FAUNA is as follows :

'Breeding in Japan, Amur and most possibly Northern China, and in winter extending to South China, the Indo-Chinese Countries, Philippines, Sumatra, Borneo, Malay Peninsula, entering south Burma as a very rare straggler only.'

It is curious to note that in all the literature consulted the Ashy Minivet is considered to be not only a rare bird, even within its geographical range, but also the most outstanding and conspicuous species of the genus.

On both the two occasions when I saw the minivets, I noticed that they moved in pairs in patches of thick forest in the light foliage canopy of trees about 20 feet in height. The specimen collected was in moult but the condition of the flight feathers revealed that it had covered a very long flight.

The specimen has been deposited in the collection of the Bombay Natural History Society and bears Register No. BNHS 22152.

ST. XAVIER'S HIGH SCHOOL,
LOKMANYA TILAK MARG,
BOMBAY, 1-BR,
February 20, 1965.

A. NAVARRO, S.J.

[As noted by Mr. Humayun Abdulali in his recent paper on 'The Birds of the Andaman and Nicobar Islands' (*Journal* **61** : 557), *Pericrocotus cinereus* Lafr. [=*P. divaricatus* (Raffles)] was recorded by A. L. Butler (*J. Bombay nat. Hist. Soc.* **12** : 394) in the Andamans. Butler's specimen, however, was not preserved being badly damaged and his record has been consistently ignored by later workers.—EDS.]

6. THE PALLAS'S GRASSHOPPER WARBLER *LOCUSTELLA CERTHIOLA RUBESCENS* BLYTH FROM SOUTH INDIA

While collecting birds with mist-nets from reed beds (*Phragmites karka* Trin.) growing by the side of paddy-field dykes in Rajapuram Kayal (= Lake), *c.* 10 km. east of Alleppey, Kuttanad, Alleppey District, Kerala, a female Pallas's Grasshopper Warbler was netted on 10 May 1963. The specimen agrees with topotypical specimens of *Locustella certhiola rubescens* in the Zoological Survey of India collected from Calcutta. Its distribution according to Ripley's SYNOPSIS is : 'A wintering form in Burma, East Pakistan, and India in the Calcutta region, Assam (Khasia Hills ?), Andaman Is. and Ceylon.'

Locustella certhiola has not been reported from Ceylon since Legge saw several examples and collected two in the Mutturajawella Swamps in February 1877 (G. M. Henry 1955). From the Andaman and Nicobar Islands we have only a sight record and a specimen collected by Dr. W. L. Abbott and Mr. C. B. Kloss (Richmond 1903). The author found the species to be rather common in Salt Lake, Calcutta, from January to March.

Its occurrence in Kerala, S. India, is a new record for the distribution of the species and race. Although Stuart Baker (F.B.I., Birds **2** : 400) includes Orissa in the range of its distribution we are unable to trace his source of information.

The measurements of the specimen are : wing 67 mm.; tail 56 mm.; tarsus 20 mm. Plumage : fresh ; two outermost rectrices of only the right side growing, evidently being replaced after accidental loss.

BOMBAY NATURAL HISTORY SOCIETY, P. V. GEORGE,
BOMBAY, 1-BR. *Research Fellow*

ST. JOSEPH'S COLLEGE, ISAAC P. MATHEW
DEVAGIRI,
CALICUT, KERALA,
February 4, 1965.

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7. WHITEHEADED YELLOW-WAGTAIL [*MOTACILLA FLAVA LEUCOCEPHALA* (PRZEVALSKI)] NEAR DELHI

On 11 April 1965 there was large-scale movement of yellow wagtails alongside the Agra Canal, which takes off from Okhla near Delhi. Most of them were Sykes's Yellow Wagtails (*Motacilla flava beema*), but there were also some Greyheaded Wagtails (*M. f. thunbergi*) and a few Yellowheaded Wagtails (*M. citreola citreola*). My eye alighted on a 'Yellowheaded Wagtail', when I realised that in fact it had a *white* head. I had it under observation for over one minute presuming it to be an aberrant specimen of the Yellowheaded Wagtail. But when I consulted the FAUNA OF BRITISH INDIA I found listed the Whiteheaded Wagtail (*M. f. leucocephala*), which apart from the white head, generally resembles *M. f. beema*. This was almost certainly the bird I saw.

The only previous record of *M. f. leucocephala*, according to Stuart Baker and Ripley (SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN), was one shot by Whistler on 3 May 1913 in Jhelum District, West Punjab.

Stuart Baker says the Whiteheaded Wagtail has been found breeding in Mongolia and Manchuria in May, June, and July. The first recorded specimen was taken in Altai.

Has anyone else seen it in India?

REUTERS,
27 PRITHVI RAJ ROAD,
NEW DELHI 11,
April 12, 1965.

PETER F. R. JACKSON

[Spring males are distinguishable from all other wagtails by the almost pure white crown, nape, and ear-coverts, the last with a faint greyish wash.—EDS.]

8. NOTES ON INDIAN BIRDS 4—ON THE VALIDITY OF *ZOOTHERA CITRINA AMADONI* (BISWAS)

In 1951, Biswas (*J. Bombay nat. Hist. Soc.* **49**: 661) described a new race of the Ground Thrush *Turdus citrinus amadoni* which was said to occur in Madhya Pradesh, Orissa, and north-eastern Madras Province. It was distinguished from the typical *Zoothera citrina citrina* (Latham) (Type locality: Cachar) by its white throat, and from *Z. c. cyanotus* (Jardine & Selby) (Type locality: Bangalore) by its larger wing and the comparative absence of the olive wash on the head. Ripley in 'The Thrushes', *Postilla* No. 13 (1952) Footnote to p. 37 and the SYNOPSIS (1961: 527) synonymized this with *cyanotus* which is the only form accepted by him as resident in peninsular India.

Recently I had occasion to examine the specimens in the Bombay collection and was struck by the fact that several white-throated males, collected by Sálim Ali at Badrama and Simlipal Hills, Mayurbhanj, in Orissa, and at Bastar and Kanker in eastern Madhya Pradesh, differed prominently from those from further south and west in having their heads an unsullied orange-chestnut almost as bright as in the typical *citrina*.

No specimens from Chanda, Madhya Pradesh, the type locality of *amadoni* were available to me, but birds of both sexes south of a line from Songadh[1], Navsari District, Gujarat, to Vizagapatam on the east coast had smaller wings and a pronounced olive tinge on the head (rendering it more yellowish khaki than chestnut). I assumed that *amadoni* would be similar to those from Orissa and eastern Madhya Pradesh, and a short note resuscitating this race on these differences was sent to Dr. Biswas for his opinion. In his reply, Biswas maintained that all recently collected males of *amadoni* also had an olive tinge on the head and sent me 4 males from Balaghat, Madhya Pradesh, in support.

An examination of the material available (41 skins) inclines me to the following conclusions:

1. Birds from Orissa and eastern Madhya Pradesh are quite distinct from those from the rest of India, being larger than and having more orange-chestnut on the head than *cyanotus*, and deserve a name;

2. Birds from Jubbulpore and Balaghat (the latter marked *amadoni* by Biswas) have slightly sullied heads, but can be separated from *cyanotus* by their larger wings and the greater amount of orange-chestnut on the head.

Biswas's type specimen, in the American Museum of Natural History, was collected by Elwes in 1867, and it is possible that 'foxing' has masked the olive tinge on the head as has happened in two females from Kanara (1890) and Bombay (1906) in the Bombay collection.

Though no specimens from Chanda are available, it may be accepted that they approach the Orissa birds in size and colour, as stated in the original description, and the race *amadoni* must be accepted, though it might have been better to place the type locality in Orissa. Its range would be as specified by Biswas (loc. cit.)—Madhya Pradesh, Orissa, and north-eastern Madras Province[2].

Throughout the ranges of *citrina*, *cyanotus*, and *amadoni* the females resemble the males, except that they average smaller, show a distinct olive tinge on the back between the head and the lower back, and perhaps have a slightly darker head. This last character may be due to the olive of the back extending on to the head.

I am grateful to the authorities of the Zoological Survey of India, Calcutta, and St. Xavier's High School, Bombay, for the loan of specimens from their collections.

75 ABDUL REHMAN STREET,
BOMBAY 3, HUMAYUN ABDULALI
February 23, 1965.

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[1] The single specimen, a male, has been included with *cyanotus*, but the wing (116 mm.) is larger, and the head which is yellow rather than chestnut does not show the olive tinge.

[2] Now Andhra Pradesh.—EDS.

9. RECOVERY OF RINGED BIRDS

Ring No. and species	Date and place of ringing	Date and place of recovery	Remarks
A-66091 *Emberiza melanocephala* ♀	22.9.1964. Hingolgadh (*c.* 22 N., 71 E.) Gujarat, India.	*c.* 16.5.1965. Famagusta, Cyprus (*c.* 35° N., 34° E.)	Reported by Mr. Loucas Papettas
AB-10606 *Tringa glareola*	17.3.1964. Manjhaul (*c.* 25·23 N., 86·30 E.), Monghyr Dist., Bihar, India	16.5.1964. At Nuya, Mukhtuya Dist., Yakutian (*c.* 60·30 N., 116·10 E.)	Reported by Bird-Ringing Bureau, USSR
B-3309 *Tringa glareola*	4.12.1964. do.	25.5.1965. 30 km. south of Yakutsk, Yakutian (*c.* 62 N., 129·40 E.)	do.
C-305 *Anas crecca* ♀	4.2.1964. do.	25.9.1964. 18 km. from Zheleznogorsk, Irkutsk region (*c.* 56·35 N., 104·10 E.)	do.
C-478 *Anas crecca* ♀ (?)	1.12.1964. do.	13.3.1965. At Yaz'yavan, Fergana Region, Uzbekistan (40·40 N., 71·45 E.)	do.
C-1769 *Anas crecca* ♂	5.12.1964. do.	9.5.1965. Near Nizhne-Ilimsk, Irkutsk region (57·20 N., 103·15 E.)	do.
C-1892 *Anas querquedula* ♂	31.12.1964. do.	18.4.1965. 7 km. from Karaganda Kazakh SSR (*c.* 49·50 N., 73·10 E.)	do.
F-3569 *Anas clypeata* ♂	16.3.1964. do.	26.5.1965. At Kyker, Tungokochen Dist., Chita region, USSR (53·10 N., 115·40 E.)	do.
C-675 *Circus macrourus* or *pygargus* ♀	25.3.1962. Bharatpur, (*c.* 27·13 N., 77·32 E.), India	7.5.1965. Near Suly, Petropavlovsk region, Kazakh SSR (53·45 N., 66·30 E.)	do.
C-1900 *Anas crecca* ♀	1.1.1965. Bakhri (*c.* 25·23 N., 86·30 E.) Monghyr Dist., India	18.4.1965. 'Kara-Kol Lace', near Osakarovka, Karaganda region, Kazakh SSR (50·33 N., 72·35 E.)	do.
Moskwa E-555512 *Anas crecca* ♂	29.7.1959. Kurgaldzhin Lake (*c.* 50·30 N., 69·35 E.), Tzelinograd region, Kazakh SSR	?.11.1963. 20 miles south of Lahore, West Pakistan (*c.* 31·25 N., 74·10 E.)	Mr. C. D. W. Savage

All the birds, except the last, were ringed in the course of BNHS/WHO Bird Migration Field Project.

Bombay Natural History Society,
Bombay, 1-br,
July 27, 1965.

EDITORS

10. NOTE ON THE SEASONAL PREVALENCE OF *CULICOIDES SCHULTZEI* (ENDERLEIN): SYNONYM *CULICOIDES OXYSTOMA* KIEFFER (CERATOPOGONIDAE: DIPTERA)

(*With a plate*)

The biting midge, *Culicoides schultzei*, is common all over India (Sen & Dasgupta 1959). It has been collected in large numbers in Rajasthan, Poona, and S. India (unpublished data, VRC). Species of *Culicoides* are regarded as vectors of African Horse Sickness in S. Africa. Though not definitely implicated in the spread of African Horse Sickness in India in 1960, *C. schultzei* was the principal suspect. This was because it was shown to feed on horses, and was widely distributed and abundant. It seemed worthwhile, therefore, to keep track of its seasonal prevalence.

The observations reported here were made at a village five miles east of Vellore, North Arcot District, Madras State. The population of the village was about 600, and the main crops were paddy and sugarcane. There were several wells with electric pumps in the area and it was possible to have three crops of paddy a year.

METHOD

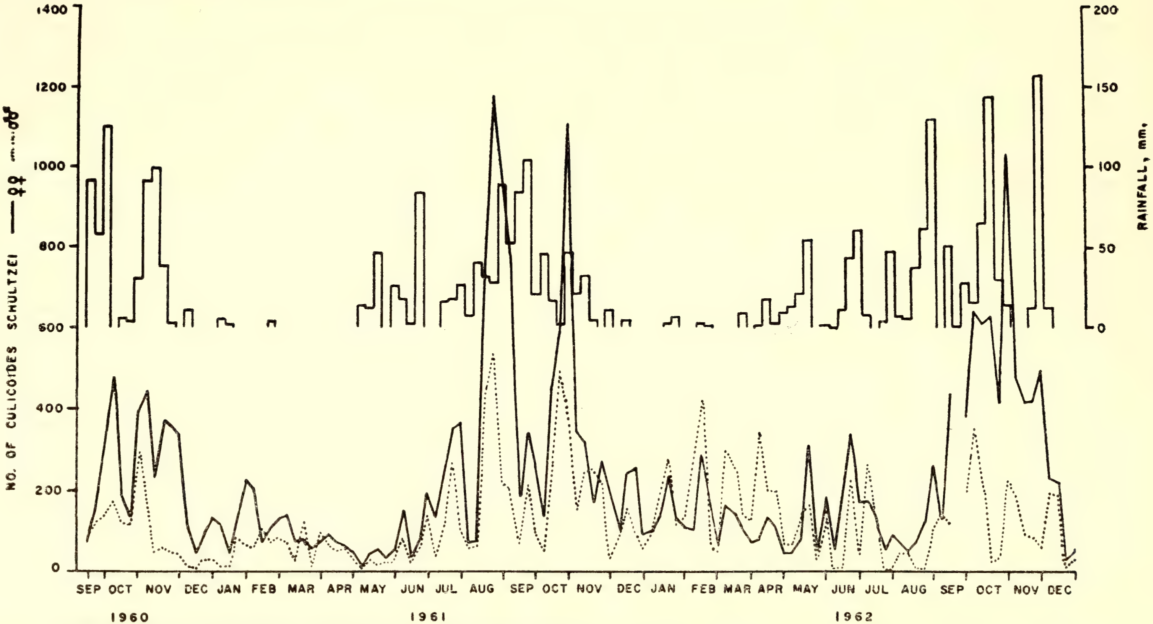
Culicoides were trapped on sticky traps made by stretching brown paper on embroidery frames, 10 in. in diameter, and smearing both sides with castor oil. Two frames were hung in each of five cattle-sheds. Insects, principally *Culicoides*, were trapped on the castor oil. The brown papers were examined and changed twice a week.

RESULTS

C. schultzei was the only species of *Culicoides* taken in large numbers on the sticky traps. *C. orientalis* and *C. peregrinus* were occasionally taken. *C. anophelis*, though often found attached to the abdomens of mosquitoes caught in the same area, did not appear in sticky trap collections.

The Figure shows the number of *C. schultzei* taken on the traps every week from 14 September 1960 to 2 January 1963 together with rainfall data for the same village. Twelve year averages of maximum and minimum temperatures at Vellore are given in the Table on p. 309. *Culicoides* collections were high during the rains from about August to November and low for the rest of the year.

Usually females were more abundant in the catches than males. Of the 17,796 females of *C. schultzei* collected in the first 81 weeks 23·8% were unfed, 72·5% were freshly gorged with blood, and 3·7% were gravid.



Weekly catch of *Culicoides schultzei* at, and rainfall data for, a village five miles east of Vellore, North Arcot District, Madras State

It seems likely therefore that they enter the cattle-sheds to feed, presumably on the cattle.

TABLE

12-YEAR (1950-1961) AVERAGES FOR MAXIMUM AND MINIMUM TEMPERATURES IN °F. AT VELLORE

Month	Max. Temp.	Min. Temp.
January ..	84·37	65·07
February ..	89·18	66·07
March ..	94·85	70·68
April ..	98·42	77·00
May ..	100·75	79·81
June ..	96·76	79·37
July ..	93·30	77·52
August ..	93·41	76·93
September ..	92·73	75·95
October ..	89·53	73·56
November ..	85·08	69·17
December ..	82·96	65·53

Culicoides larvae have been found occasionally in paddy-field water. Attempts to rear them were not successful. However, several pupae were collected from a corner of a fallow field, where there was a thick scum on the water. These were brought to the laboratory, where 3 male and 4 female *C. schultzei* emerged.

VIRUS RESEARCH CENTRE[1], R. REUBEN
POONA,
March 24, 1965.

REFERENCE

SEN, P., & DASGUPTA, S. K. (1959): Studies on Indian *Culicoides* (Ceratopogonidae: Diptera). *Ann. ent. Soc. Amer.* **52**: 617-630.

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[1] The Virus Research Centre is jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation. The Centre also receives a grant from the National Institutes of Health, U.S.A., from PL 480 Funds.

11. INSECT FAUNA OF NEPAL : PART I. CURCULIONIDAE

(*With a map*)

As a member of the Indian Agricultural Research Institute Expedition to Nepal, one of the authors (SRW) made insect collections from there; the present paper deals with the weevils collected. The party trekked from Butwal to Muktinath via Tansen, Pokhara, Birethanthi, Tatopani, and Jhomsum, and then back to Pokhara (see Map). The trek lasted from 31 March to 15 May 1961.

The weevils collected were identified in part in the British Museum, and the rest with the help of the National Pusa Insect Collection maintained in the Division of Entomology, Indian Agricultural Research Institute, New Delhi, to which collection all the material now collected has been added. The weevils fall under the following 18 genera and 28 species and number over 200 specimens (excluding those of *Sitophilus oryzae* Linn.). The genera marked * have already been noted from Nepal (Kono 1959, and von Dalla Torre & Voss 1930). The remaining genera and 27 species (excluding *S. oryzae*) constitute new records for that country. Of the collection, the genus *Telephae* and the species marked † are not represented in the National Pusa Insect Collection, and hence are new additions.

DETAILED ACCOUNT OF THE COLLECTION

†1. **Acanthotrachelus** sp. One example. Collected at Jhomsum (*c*. 2703 m.) on 25-4-61.

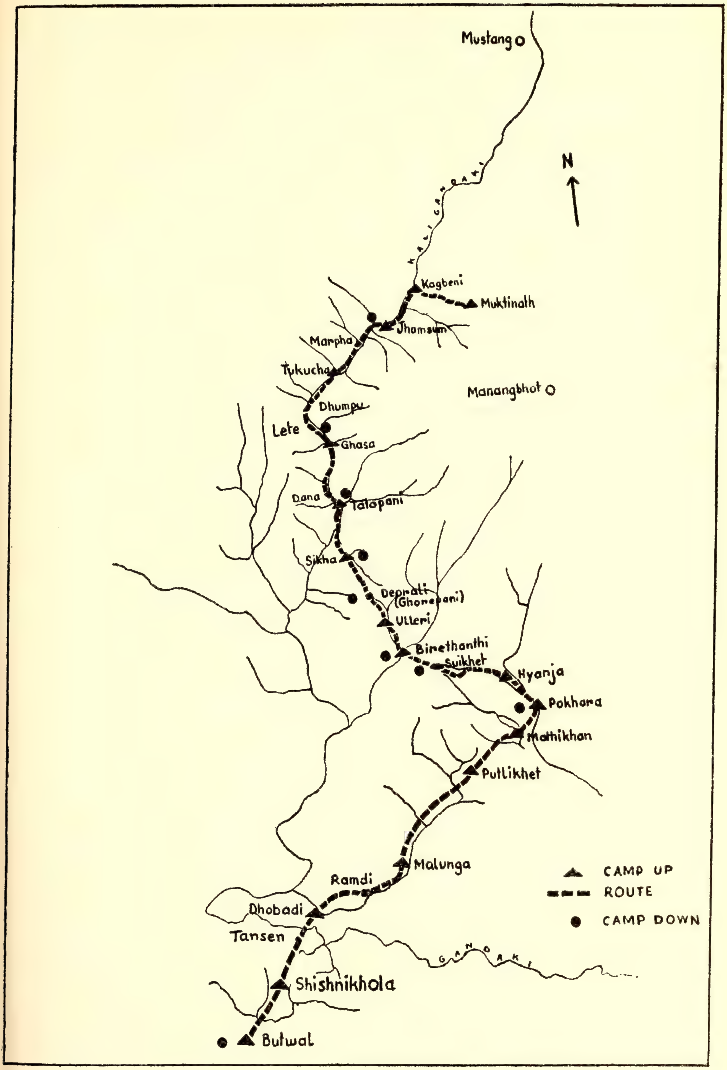
†2. **Apion** sp. 1. Six examples. Collected at Modikhola (near Birethanthi *c*. 1115 m.) on 14-4-61.

†3. **Apion** sp. 2. One hundred and forty examples. Most of these specimens were collected from an *Adathoda vasica* plant at Shishnikhola (*c*. 620 m.) on 31-3-61. The plant was literally swarming with these weevils. This species was also collected on *Citrus* at Dana (*c*. 1420 m.) on 20-4-61 and 7-5-61, at Mashem (*c*. 1200 m.) on 31-3-61, at Karadikhola (near Bhomre *c*. 650 m.) on 3-4-61, at Ulleri (*c*. 2019 m.) on 15-4-61, at Ghara (*c*. 1821 m.) on 8-5-61, and at Birethanthi on 12-5-61.

†4. **Apion** sp. 3. One example. Collected at Mashem on 31-3-61.

The salient points that separate these three species from each other are given in Table at p. 312.

5. **Apion benignum** Fst. Three examples. Collected from a fig tree at Birethanthi on 13-5-61, on a wild plant near Mashem on 31-3-61, and on *Adathoda vasica* at Shishnikhola on 31-3-61.


Mustang
N
KALI GANDAKI
Kagbeni
Muktinath
Jhomsum
Marpha
Tukucha
Manangbhot
Dhumpu
Lete
Ghasa
Dana
Tatopani
Sikha
Deorali
(Ghorepani)
Ulleri
Birethanthi
Suikhet
Hyanja
Pokhara
Mathikhan
Putlikhet
Malunga
Ramdi
Dhobadi
Tansen
GANDAKI
Shishnikhola
Butwal
▲ CAMP UP
▬ ▬ ▬ ROUTE
● CAMP DOWN

Insect Fauna of Nepal. Curculionidae
Map showing area in which collections were made

6. **Apion clavipes** Gerst. Two examples. Collected from wheat plants at Dumre (*c.* 650 m.) on 1-4-61 and at Mashem on 31-3-61.

*7. **Apoderus blandus** Fst. Two examples. Collected at Nuwankot (*c.* 1475 m.) on 5-4-61 and at Modikhola on 14-4-61.

8. **Balaninus nigricollis** Mshll. Two examples. Collected at Pokhara (*c.* 967 m.) on 8-4-61.

*9. **Centrocorynus scutellaris** (Gyll.). Six examples. Collected at Bhagnas (near Dhobadi *c.* 900 m.) on 2-4-61 and at Ghara on 8-5-61.

10. **Emperorhinus defoliator** Mshll. One example. Collected at Mattikhan (*c.* 1350 m.) on 5-4-61.

11. **Lixus linguidus** Fst. One example. Collected at Ghara on 21-4-61.

†12. **Lobotrachelus lepidotus** Mshll. One example. Collected at Modikhola on 14-4-61.

†13. **Lobotrachelus urenae** Mshll. Two examples. Collected from *Adathoda vasica* at Shishnikhola on 31-3-61.

†14. **Metialma** sp. Two examples. Collected at Ghara on 8-5-61.

15. **Metialma ? anisomelis** Mshll. Nine examples. Collected from *Adathoda vasica* plant at Shishnikhola on 31-3-61 and from fig tree at Birethanthi on 13-5-61.

†16. **Metialma cordata** Mshll. Four examples. Collected from fig and *Citrus* at Birethanthi on 13-5-61 and at Modikhola on 14-4-61.

Metialma sp. is comparatively larger than both *anisomelis* and *cordata*. It also differs in having the funicular segments together equal to the scape and in the pronotum being without a distinct raised area.

17. **Myllocerus kashmirensis** Mshll. Two examples. Collected at Ghasa (*c.* 1958 m.) on 21-4-61, and 22-4-61.

†18. **Myllocerus planoculis** Mshll. One example. Collected at Pokhara on 8-4-61.

†19. **Myllocerus viridulus** Mshll. Two examples. Collected from peach at Ghasa on 21-4-61.

†20. **Nanophyes** sp. Eleven examples. Collected from *Adathoda vasica* plant at Shishnikhola on 31-3-61, on *Sarcococa* sp. leaves at Karadikhola on 3-4-61, and at Modikhola on 14-4-61.

*21. **Paroplapoderus (Paroplapoderus) bihumeratus** (Jek.). One example. Collected at Mattikhan (*c.* 1350 m.) on 5-4-61.

†22. **Ptochus percusus** Fst. One example. Collected at Chandrakot (near Lumley *c.* 1586 m.) on 13-4-61.

†23. **Rhynchaenus** sp. 1. One example. Collected on *Citrus* at Dana on 7-5-61.

†24. **Rhynchaenus** sp. 2. Three examples. Collected from peach at Ghasa on 21-4-61, at Nuwankot on 5-4-61, and at Modikhola on 14-4-61.

These two species of *Rhynchaenus* can be separated from each other by the small yellowish beak and elytra without yellowish patches in

TABLE

DISTINGUISHING CHARACTERS OF THE THREE SPECIES OF *Apion*

Character	sp. 1	sp. 2	sp. 3
Length	2·75-3·00 mm.	3·00-3·5 mm.	4 mm.
Width	1·0 mm.	1·5 mm.	1·75 mm.
Body	Partly black	Black	Black
Rostrum	As long as the head and thorax together	As long as the head and thorax together	Much longer than head and thorax together
Antenna	Yellowish testaceous	Black	Black
Legs	Coxae and trochanters black. Fore-femora yellowish testaceous in middle and smoky at the two extremities. Mid- and hind-femora black. Tibiae yellowish testaceous in the middle. Tarsi fuscous	Black	Black
Elytra	Convex Striae fine, distinct Intervals convex with short whitish recumbent setae, punctation regular	Globular Striae fine Intervals broad, smooth and flat, punctation scant, without setae	Globular Striae deep Intervals broad, rough and flat, without punctation and setae

sp. 1 and by the long brownish beak and elytra with yellowish patches in sp. 2.

25. **Sitona crinitus** Oliv. Two examples. Collected from barley at Ulleri on 19-4-61 and at Chandrakot on 13-4-61.

*26. **Sitophilus oryzae** Linn. Several examples. Collected at various places all along the route from paddy, maize, and wheat in storage. However, the other species of *Sitophilus*, *S. sasakii*, reported earlier (Kono 1959) is conspicuous by its absence in the present collection.

27. **Tanymecus ? tetricus** Fst. One example. Collected at Suikhet (*c*. 1187 m.) on 14-5-61.

†28. **Telephae** sp. One example. Collected at Birethanthi on 13-5-61.

The authors are grateful to Dr. S. Pradhan, Head of the Division of Entomology, for the facilities provided to process the collection and to Dr. M. G. Ramdas Menon, Systematic Entomologist, I.A.R.I., for going through the manuscript and for making some very valuable suggestions. They are also grateful to His Majesty's Government, Nepal, and Shri Harbhajan Singh, leader of the party, for facilities given for making these collections. The assistance rendered by the British Museum (Natural History) in establishing the identity of a number of species is gratefully acknowledged.

DIVISION OF ENTOMOLOGY,
INDIAN AGRICULTURAL RESEARCH INSTITUTE,
NEW DELHI 12,
December 10, 1964.

S. R. WADHI
BALDEV PARSHAD

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VON DALLA TORRE, K. W., & VOSS, E. (1930) : Coleopterorum Catalogus. (Curculionidae : Apoderinae), pars **110** : 5,23, and 29.

12. INSECT ATTACKS ON AND DISINFESTATION OF SOME EDIBLE FUNGI IN INDIA

Exporters of the edible fungi, *Cantharellus cibarius* Fr. and *Morchella esculenta* Linn., which grow in the Himalayan region of Jammu and Kashmir State, finding difficulty in the acceptance of consignments due to presence of insect infestation, brought the matter to the notice of the Directorate of Plant Protection, Quarantine and Storage. The results of some investigation undertaken by the Directorate, for disinfestation of stocks of fungi are reported here.

The two fungi are stored for varying periods between collection and marketing. Insect infestation may occur either in the natural habitat or from cross-infestation from other commodities in the store, or from both these sources. From *C. cibarius* the insects recorded were a tiny beetle belonging to the family Cisidae (order Coleoptera)[1] and a rust-red flour beetle (*Tribolium castaneum* Herbst.), and from *M. esculenta* the cigarette beetle (*Lasioderma serricorne* F.). The extent of infestation and its possible source and the nature of the damage are set out below.

INFESTATION

The dried specimens of *Cantharellus cibarius* were attacked by the Cis beetle by making round or elongate holes on the surface of the pileus and the stipe alike and eating the soft pithy core from the inside; on pressure a mass of brownish powder was given out. Severely damaged mushrooms showed innumerable holes. As many as 30 adults were found per mushroom.

The beetle is reddish brown in colour, 2 mm. long, head deflexed and concealed under the pronotum, antennae clubbed, dorsal surface of the body covered with yellowish pubescence arranged on the pronotum on either side of the mid-longitudinal line. The head of the male bears a pair of minute horn-like projections on the frons, and the pronotum another pair, bigger and raised, on the anterior margin. In the female the projections are wanting.

As Cis beetles occur on dead wood and fungi (Beeson 1941) it is probable that the initial source of infestation is the decaying wood over which *C. cibarius* grows and that the pest multiplies later on the fungi during transport and storage.

As *Tribolium castaneum* is a surface feeder, the damage inflicted by it is not as severe as that of the Cis beetle. It has a wide host range and the infestation on the fungi is presumably from cross-infestation from other stored agricultural commodities.

The dried specimens of *Morchella esculenta* were attacked by adults and larvae of *Lasioderma serricorne*. Minute round holes in the surface led to irregular galleries inside. Severely damaged morels were hollow and yielded powdery matter on tapping. As many as 8 adults were recorded in one morel. The infested commodity is unfit for consumption. The green stage of the morel has been reported to be attacked by maggots (Vasudeva 1956).

L. serricorne occurs as a serious pest of tobacco, but has been reported to attack coriander, cumin, turmeric, chillies, and ginger (Thomas 1946). *Morchella* appears to be a previously unreported host of the pest.

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[1] Specimens have been sent to the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, U.S.A., for identification.

DISINFESTATION

Infested stock of *C. cibarius* and *M. esculenta* were fumigated with methyl bromide in Delhi. Fumigation was carried out in a room made gas-tight by pasting paper on the doors, windows, and ventilators. In all, 90 kg. of the mushroom and 60 kg. of the morel packed in five plywood tea-chests were fumigated at a density of 1 lb. per 1000 cu. ft., with an exposure period of 45 hours at a temperature between 21° C. and 33° C. After fumigation the room was opened and, after thorough aeration for four hours, the stocks were examined for determining the efficacy of methyl bromide. No surviving insects could be collected from the whole stock and, even after one year's storage, no living insects were observed on the stored fumigated material.

The fungi treated in the dry state with methyl bromide and aerated as described are unaffected as regards both taste and edibility and, as no toxicity remains after aeration, may safely be eaten. No chemical change in the fungus attributable to fumigation has been reported or found. The treatment, however, does not protect the fungus against cross-infestation. So proper storage of fumigated fungi in insect-free godowns is necessary.

DIRECTORATE OF PLANT PROTECTION
QUARANTINE AND STORAGE,
MINISTRY OF FOOD & AGRICULTURE,
DEPARTMENT OF AGRICULTURE,
NEW DELHI,
February 12, 1965.

B. K. VARMA
S. P. GURWARA

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VASUDEVA, R. S. (1956): The Wealth of India. Raw Materials, F. G. **4**: 87.

13. COLLECTING MOTHS BY A MERCURY VAPOUR LAMP IN THE SURAT DANGS, GUJARAT STATE: AN EXPLANATION

Mr. D. G. Sevastopulo, P. O. Box 5026, Mombasa, writing with reference to the paper 'Collecting moths by a mercury vapour lamp in the Surat Dangs, Gujarat State', published at pp. 281-294 of Volume 61, condemns as non-scientific the listing of genera in alphabetical sequence. He also points out that some of his distribution records from Calcutta have not been listed.

In reply, the authors explain that as their paper is addressed mainly to general readers and field entomologists they have followed a method sanctioned by previous practice—see C.F.C. Beeson (1941) : THE ECOLOGY AND CONTROL OF THE FOREST INSECTS OF INDIA AND THE NEIGHBOURING COUNTRIES ; and M. S. Mani & Santokh Singh (1961 and 1962) : 'Entomological Survey of Himalaya', published in volumes 58 to 60.

An errata slip is issued separately to correct errors and omissions pointed out by Mr. Sevastopulo.

BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY, 1-BR, EDITORS
April 21, 1965.

14. ON THE OCCURRENCE OF THE TUBE-WORM *LOIMIA MEDUSA* (SAVIGNY) IN BOMBAY WATERS AND ITS COMMENSALISM WITH A PORCELLANID CRAB

(*With one plate*)

While digging for Thalassinids mud-lobsters at Chowpatty, Bombay, on 14 Jan. 1964, a porcellanid crab (Plate, c and d) was seen emerging from the tube of a tube-worm *Loimia medusa* (Savigny) [Annelida: Terebellidae] (Plate, a and b). The crab was identified as *Polyonyx* sp. (Crustacea: Anomura). Further taxonomic determination was not possible as the crab was not represented in the collection of *Polyonyx* material with the senior author and did not agree with the description of any known species. The crab is being described separately by the senior author[1]. The present paper records behaviour studies of the two associated animals *Loimia* and *Polyonyx*, which were always found together in several collections made subsequently.

In India, *L. medusa* has been recorded on the east coast from Madras by Fauvel (1930 and 1953) and from Krusadai Island by Gravely (1927), but without any mention about its commensalism. Hence, this is the first record of the worm as a commensal and of its occurrence on the west coast of India.

From previous records, the association of *Polyonyx* with other animals seems to be a common feature. Miyake (1945) found *P. utinomi* and *P. macrocheles* both commensal with *Chaetopterus*. Johnson (1958) described *P. macrocheles*, *P. utinomi*, and *P. sinensis* in association

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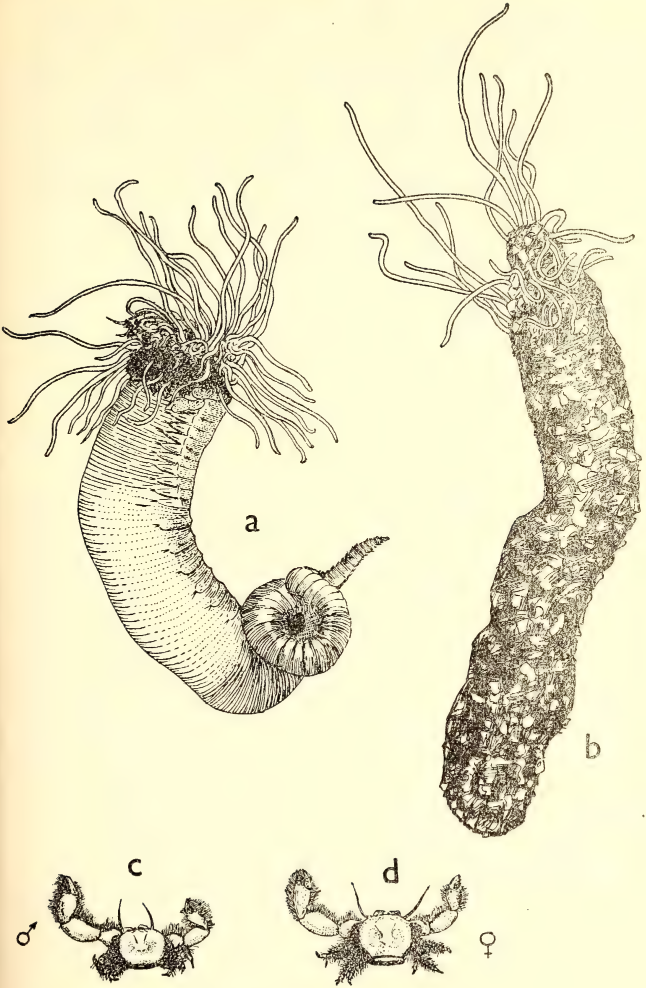
[1] See K. N. Sankolli: 'On a new species of commensal porcellanid crab, *Polyonyx loimicola* sp. nov. from India: (Crustacea, Anomura, Porcellanidae)', at pp. 285-291 above.



Loimia medusa (Savigny) and *Polyonyx loimicola*

a. Worm without tube. Note the swollen condition. *b*. Broken tube with the worm inside. *c*. Commensal crab, male. *d*. Commensal crab, female
(natural size)

with *Chaetopterus* sp., *P. cometes* and *P. transversum* with the bivalve *Aspergillum*, and *P. telestophilus* on the branches of an Alcyonarian, *Telesto* sp. Haig (1960) describes *P. quandrangulatus* as commensal with *Chaetopterus variopedatus*, mentioning that only the larger tubes had the crabs in them.

From India, only two species of *Polyonyx*, viz. *P. obesulus* and *P. hendersoni* have been recorded, and a third is being described (in the press, Sankolli). Of these *obesulus* is found to occur in sponges (Gravely, op. cit.) and as a crevice-dwelling form (Johnson, op. cit.); *hendersoni*, though not living in association with any other animal, occurs in colonies of corals and sponges (Johnson, op. cit.); and the new species is found to occur in sponge colonies. None of these three, however, has been reported as a true commensal. Besides *Polyonyx*, interesting observations have been made on the association of *Porcellanella* sp. with the sea pen *Pteroides esperi* by Jones (1959).

FIELD OBSERVATIONS

The tubes of *L. medusa* project ½ to 2 in. above the ground and can be easily spotted during low tide in the intertidal zone. The exterior opening of the tube measures at most ¼ in. in diameter and the length of the tube varies between 8 and 12 in. Attempts to take out the entire tube with the worm in it were not successful. The tubes were found mostly on the leeward side of stones or boulders, lying either in sand or in a mixture of sand and mud, where generally Thalassinids, especially Upogebiids, abound. It was often observed that the tubes ran almost parallel to the burrows of the Upogebiids. Each tube is unbranched and is composed mainly of calcareous pieces and sand grains cemented together by a sticky substance. The tube did not wrap the worm along its attachment to the rocky substratum.

The worm is 8 to 10 in. long, brownish green in colour, with whitish tentacles, much-branched brownish red gills, and red ventral plates.

The commensal crabs are always found in a pair inside a tube. They are hairy and light-brown in colour, matching well with the tube. Most of the females were in berried condition.

OBSERVATIONS IN CAPTIVITY

The behaviour of the worm and the commensal crabs was studied independently and also in relation to each other in a series of small aquarium tanks, each measuring 12 in. × 9 in. × 9 in. For simulating the natural habitat, about 3 in. layer of coarse sand gathered from the locality where they were collected was spread out on the bottom of the tanks.

The worms, without tubes or with parts of broken tubes, displayed vigorous rhythmic dilations and contractions of the girth of the body, the movements originating from the posterior end of the trunk and progressing to the anterior end. These movements were relatively much less vigorous in worms with almost intact tubes.

The worms, especially those deprived of their tubes, would extend their tentacles and contract them immediately on the slightest mechanical disturbance, e.g. if the tentacles or the body were touched with a finger or a glass rod. After a while, if left undisturbed, the activity would be resumed. If a tentacle came in contact with a shell piece in the sand, it would start contracting bringing the shell piece with it towards the head end, at the same time repeatedly rolling it as though something sticky was being secreted on to it. After a while the piece would be dropped near the head end. Though this behaviour continued for 8 to 12 hours, the worm failed to build a tube. It would remain contracted in length with occasional attempts to build a new tube, but there would be vigorous pulsations in girth and the main part of the body would continue swollen for hours. In the swollen state the girth was 2 to 2½ times the normal girth (slightly less than ¼ in.) inside the tube. The naked worms survived for 5-7 days but a few died even earlier than 48 hours.

With a view to increasing the survival period and assisting the worm in building a new tube, plastic and rubber tubes of suitable diameter and length were tried but without success as the worm wriggled out of the tube almost immediately after introduction.

Further observations were made with specimens provided with partly broken tubes of 1 to 3 in. length. The shell pieces rolled by the tentacles near the head end, instead of being just dropped as in the case of naked worms, were stuck on to the anterior end of the broken tube by the tentacles. These pieces could not be easily pulled out with a forceps, indicating that the shell pieces or sand particles were pasted with an adherent, which is probably secreted by the collar or oral region of the worm. The adherence of the shell particles to the tentacles suggests that the tentacles are also capable of secreting mucous-like sticky substance.

The tube material was thus added piece by piece till, in nearly two hours, about ½ in. length of new tube was added to the anterior end of the old tube. After adding the new portion in this manner, the worm gradually pushed itself inside till the whole animal was covered by the tube. The building of the tube, however, continued till it reached a length of 10-12 in. and this was achieved within 48 hours. The length of the rebuilt tubes, often ranged from 18-24 in., the tubes many a time taking a zig-zag course, which might have been due to the limited depth of the sand column and other artificial conditions in the experimental tanks. The tubes always had two openings, one at each end.

The worms with the rebuilt tubes thrived well for as long as 50 to 90 days in the laboratory.

The tube thus constructed was composed mainly of shell pieces. Here too the tubes were formed against a hard surface, like that offered by the bottom glass or the bitumen coating along the angles of the tank. The tube when formed on the glass surface had a transparent side, devoid of shell and sand particles. This rendered it possible to make observations on the worm and its commensals while inside the tube, for the tanks were supported on a stand 6 ft. in height, open from below, permitting necessary observations to be made through the bottom.

The commensals invariably held on to the inner surface of the tube and kept their dorsal surface in contact with the body of the worm, behaviour which lessens the danger of hurt to the soft-bodied host. Generally, one crab was found near the head end and the other near the trunk region of the worm. If the worm was disturbed gently, it would either double back on itself or retract and go some distance inside the tube away from the source of disturbance, and the crabs would move along with the worm. After some time, if left undisturbed, the worm would come back to the opening and the crabs would accompany it. If, however, the disturbance was repeated many times or was of vigorous intensity, the worm would move backwards rapidly to the other end of the tube and, a few minutes later, its tentacles might be seen exposed at this opening; the crabs, however, would normally remain in their original positions.

On muddy water with *Artemia* nauplii being introduced near the opening of the tube, the worm would immediately reach out to the opening and the activity of the tentacles would be increased accompanied by intermittent jetting out of water from the mouth of the tube. Now, both the crabs would come towards the head end of the worm and rapid sweeping action of their third maxillipeds could be seen as though they were feeding.

It was equally interesting to study the behaviour of the commensals. Alone or in a pair the crabs lived happily in the company of the worm. If they were kept separated from the host and its tube, they were found dead the very next day. If, however, a small or large piece of empty tube was provided, the crab lived inside it for about a month or so. If, now, a worm in its tube was introduced into the tank, the crab would eventually harbour with the host. Crabs, dislodged from their hosts with tubes in the same tank, crawled frantically about and, when they came near the tube or the tentacles of the worms, would immediately make attempts to enter into the tube. During this process, attempts to dislodge them while still outside the tube made them hold fast to any part of it. On their side the worms did not seem dependent for their welfare on the presence or absence of the commensal crab or crabs.

Attempts were made to study the hatching of the eggs since most of the female commensal crabs were ovigerous. The eggs successfully hatched only when the crabs were kept along with their hosts in tubes. If a berried female had either a host without a tube or a tube without a host, the eggs were shed unhatched, though the crab was apparently in normal condition. Hence, the association of the commensal crabs with the host in its tube appears to be a necessity for a successful hatching.

ACKNOWLEDGEMENTS

We are thankful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra, for giving us facilities for this study, and to Dr. H. G. Kewalramani, Senior Scientific Officer, for his constructive criticism.

TARAPOREVALA MARINE BIOLOGICAL
RESEARCH STATION,
BOMBAY,
March 8, 1965.

K. N. SANKOLLI
SHAKUNTALA SHENOY

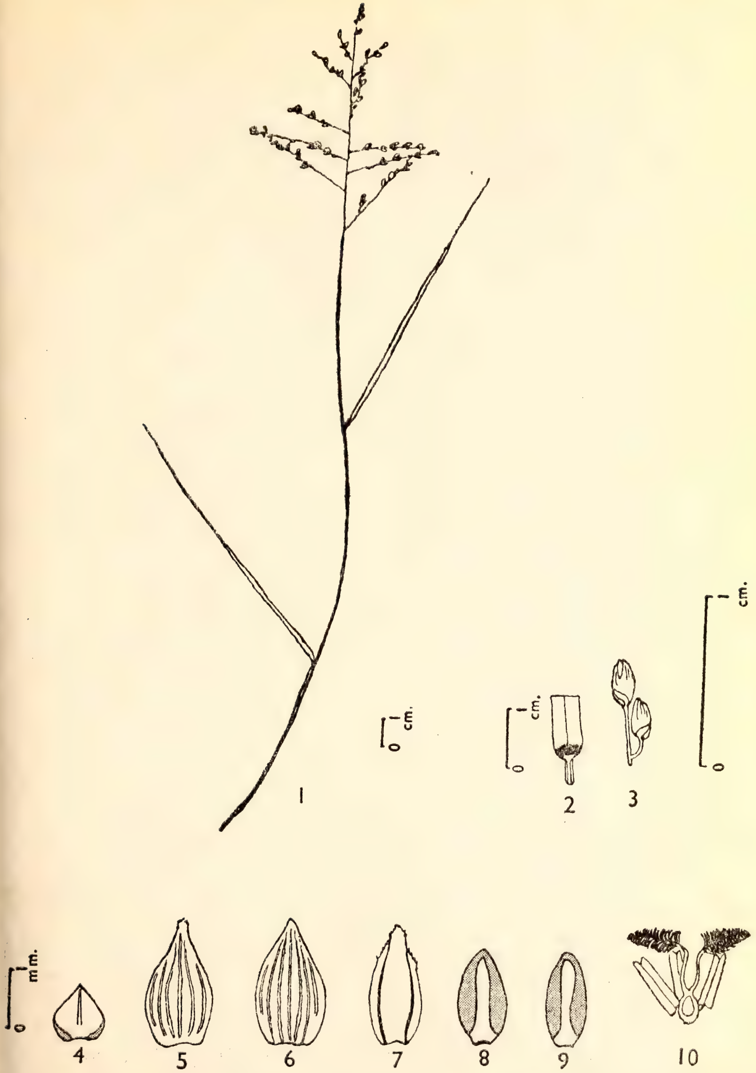
15. A NEW SPECIES OF *PANICUM COLORATUM* LINN. COMPLEX

(*With two plates*)

Panicum simpliciflorum Jauhar et Joshi, sp. nov.

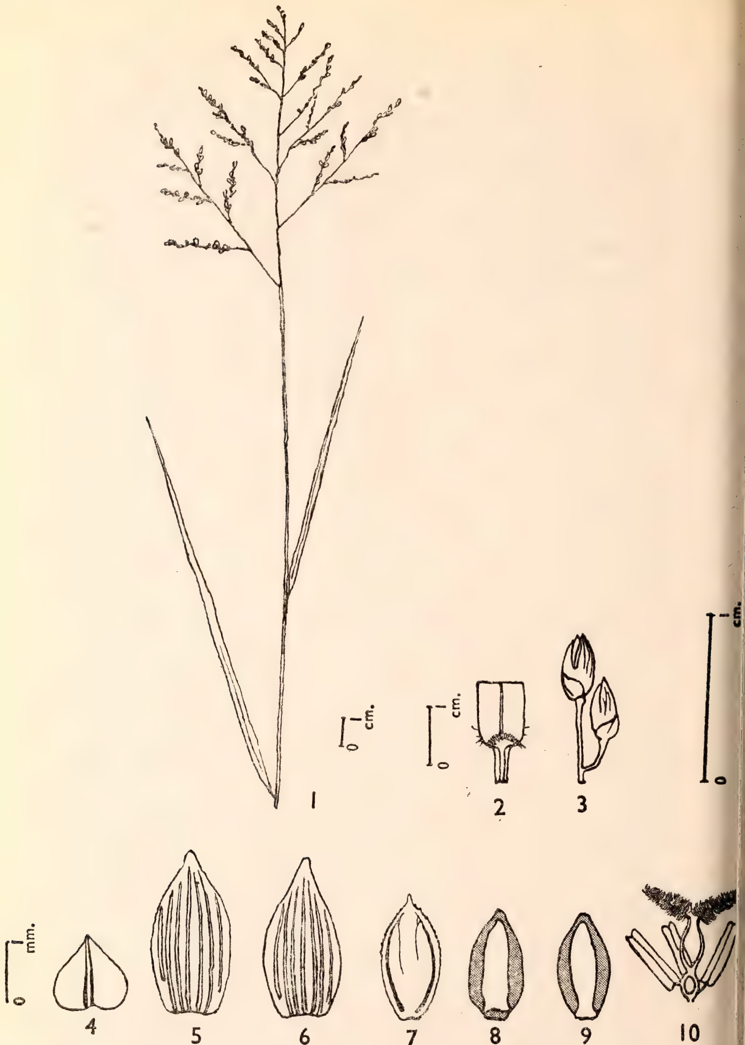
Affinis *Panico colorato* Linn., a quo tamen differt praecipue (i) culmis gracillimis, penitus glabris, (ii) foliis brevibus, angustis, glabris, (iii) panicula simplici, sparse ramosa, racemi instar, (iv) spiculis brevibus, subacutis, (v) partibus floralibus (glumis et lemmate inferiore) rarioribus et inconspicue nervosis, et (vi) structura distincta epidermali foliorum monstrante 'cellulas longas' longas et angustas, ornatas parietibus perpendicularibus tenuiter undulatis et inconspicue cuticulatis.

Gramen perenne, gracile, alte caespitosum, dense fasciculatum, stenophyllum, glabrum, tetraploideum, habitu erecto fruticoso. *Culmi* 90-110 cm. alti, 5-8-nodi, teretes, ad 1·6 mm. crassi; nodi glabri. *Folia* brevia, angusta, acuminata, glabra, nervo medio inconspicuo; folium secundum 14-20 cm. longum, 0·3-0·6 cm. latum; vaginae foliorum glabrae. *Ligula* 1·3-1·5 mm. longa, fimbriata. *Inflorescentia* sparse ramosa, racemi instar, paniculata, 12-20 cm. longa, 6-9 cm. lata; rami secundarii emergentes erachide principe supportant spiculas



Panicum simpliciflorum Jauhar et Joshi, sp. nov.: a culm with panicle, spikelet, and constituent parts of a spikelet

1. Culm with a simple, raceme-like panicle; 2. A portion of leaf showing ligule; 3. A pair of spikelets (note the sub-acute apices); 4. Lower glume, a short, orbicular structure, inconspicuously 1-nerved; 5. Upper glume; 6. Lower lemma; 7. Lower palea with apical margins serrulated; 8. Upper lemma; 9. Upper palea; 10. Pistil and stamens



Panicum coloratum L.: a culm with panicle, spikelets, and constituent parts of a spikelet

1. Culm with effuse panicle; 2. A portion of leaf showing ligule; 3. **A pair of spikelets; 4. Lower glume; 5. Upper glume; 6. Lower lemma; 7. Lower palea wit serrulated margins; 8. Upper lemma; 9. Upper palea; 10. Pistil and stamens. Note conspicuous nervation of the glumes and lower lemma.**

geminas, longe inter se distantes. *Spiculae* subacutae, flaccidae, 2·2-2·5 mm. longae, 2-florae, flore inferiore staminato, superiore vero hermaphrodito. *Gluma inferior* brevis (0·8-1·1 mm. longa), orbicularis, spiculam amplectens, inconspicue 1-nervia. *Gluma superior* ut lemma inferius, 5-7-nervia, nervis inconspicuis. Palea inferior 2-nervia, marginibus debiliter dentatis, hyalina. Flos hermaphroditus fere ovalis forma, plano-convexus ; lemma coriaceum, laevigatum. *Stigmata* 'Tyrian' purpurea (Ridgway 1912). *Antherae* 1·0-1·4 mm. longae, citrinae.

Oriundus ex Australia, in speciem distinctam elevatus post cyto-taxonomicam investigationem, typus positus in herbario sectionis botanicae Instituti Indici Agriculturae ad New Delhi sub numero *P. P. Jauhar* 2 : isotypi, *P. P. Jauhar* 2 *A, B, C,* deponendi in herbario ad Dehra Dun, ad Calcuttam et ad Kew in Anglia.

Panicum simpliciflorum Jauhar et Joshi, sp. nov.

The species is allied to *Panicum coloratum* L. (Plate II) but differs from it chiefly in having: (i) very thin, perfectly glabrous culms, (ii) short, narrow, glabrous leaves, (iii) a simple, scantily-branched, raceme-like panicle, (iv) short, sub-acute spikelets, (v) fewer and inconspicuously-nerved floral parts (glumes and lower lemma) (Plate I), and (vi) long and narrow 'long cells' with feebly rippled and inconspicuously cuticularised anticlinal walls. The following table shows, in bare outline, the broad points distinguishing the two species (for details, see Jauhar 1963):

Character	*Panicum coloratum* L.	*P. simpliciflorum* Jauhar et Joshi, sp. nov.
Morphological features		
(i) Culms	Medium thick to thick, glabrous to glabrescent culms with or without nodal-fuzziness, branched or unbranched above	Very thin, perfectly glabrous culms without nodal-fuzziness, branched above
(ii) Leaves and Leaf-sheath	Short to long, mostly glabrescent leaves and leaf-sheaths	Short, narrow, glabrous leaves and leaf-sheaths
(iii) Inflorescence	A semi-effuse to highly effuse, strongly branched panicle	A simple, raceme-like, scantily-branched panicle
(iv) Spikelets	2·6-3·6 mm. long, generally acute to acuminulate spikelets	2·2-2·5 mm. long, subacute spikelets
(v) Nervation of floral parts	More- and conspicuously-nerved glumes and lower lemma	Fewer- and inconspicuously-nerved glumes and lower lemma
(vi) Foliar epidermal pattern	Short to medium-long 'long cells' (100-150μ long and 15-23μ broad) with feebly to conspicuously rippled and cuticularised anticlinal walls	Long and narrow 'long cells' (135-165μ long and 12-17μ broad) with feebly rippled and inconspicuously cuticularised anticlinal walls

The species does not cross with *Panicum coloratum*; all concerted efforts, using a variety of techniques and procedures, to obtain a hybrid failed.

A slender, highly caespitose, densely tufted, stenophylous, glabrous, tetraploid ($4x=2n=36$), perennial with erect bushy growth habit. Culms 90-110 cm. tall, 5- to 8-noded, terete, up to 1·6 mm. thick. Nodes glabrous, i.e. free from nodal-fuzziness. Leaves short, narrow, acuminately pointed, glabrous, mid-rib highly inconspicuous; second leaf 14-20 cm. long and 0·3-0·6 cm. broad; leaf-sheaths glabrous. *Ligule* 1·3-1·5 mm. long, fimbriate.

Inflorescence, a scantily-branched, raceme-like panicle, 12-20 cm. long and 6-9 cm. broad. The secondaries arising from the main rachis directly bear widely-spaced, paired spikelets. *Spikelets* sub-acute, flaccid, 2·2-2·5 mm. long, 2-flowered—the lower staminate and the upper hermaphrodite. *Lower glume* short (0·8-1·1 mm. long), orbicular structure clasping the spikelet, inconspicuously 1-nerved. *Upper glume*, like the *lower lemma*, 5- to 7-nerved, the nerves being inconspicuous. *Lower palea* 2-nerved, with feebly dentate margins, hyaline. *Hermaphrodite* floret almost oval in shape, plano-convex; *lemma* coriaceous, levigate. *Stigmas* 'tyrian rose' in colour (Ridgway 1912). *Anthers* 1·0-1·4 mm. long, lemon-yellow.

Some of the salient features of the epidermal pattern are:

Long and narrow 'long cells' with inconspicuously cuticularised and feebly rippled anticlinal walls; occurrence of rectangular to saddle-shaped 'short cells' between the long cells.

The type was isolated from a composite seed lot of *Panicum coloratum* obtained originally from Australia. On the basis of cytotaxonomic investigations by the authors, the specimen has been elevated to specific rank. Type *P. P. Jauhar* 2, in Herbarium, Botany Division, Indian Agricultural Research Institute, New Delhi; isotypes to be deposited in the Herbaria of Dehra Dun (*P. P. Jauhar 2A*), Calcutta (*P. P. Jauhar 2B*), and in Kew, England (*P. P. Jauhar 2C*).

ACKNOWLEDGEMENTS

We are highly indebted to Rev. Prof. H. Santapau, F.N.I., Director, Botanical Survey of India, Calcutta, for his valuable suggestions with regard to the nomenclature of the taxon and for kindly rendering the diagnosis into Latin. We express our cordial thanks to Dr. M. S. Swaminathan, Head of the Division of Botany, to Shri H. B. Singh, Head of the Division of Plant Introduction, to Dr. N. L. Dhawan, Geneticist, and to Shri B. D. Patil, formerly Assistant Agrostologist, all at this Institute, for their critical comments and suggestions. The

senior author is also thankful to the Indian Council of Agricultural Research for the award of a Senior Research Fellowship of the Council for the present work.

BOTANY DIVISION,
INDIAN AGRICULTURAL RESEARCH
INSTITUTE,
NEW DELHI 12,
April 6, 1965.

PREM P. JAUHAR
A. B. JOSHI

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16. *LAURENTIA LONGIFLORA* (LINN.) ENDL. IN PONDICHERRY

Two years ago Mr. Parichand of Shri Aurobindo Ashram, Pondicherry, showed me a small herbaceous plant with attractive white flowers. According to him the Mother of the Ashram spoke of it as signifying ' Divine Purity ' and, as it grew in the shade, the plant was used in pots as an interior decoration in the Ashram ; this stopped when the gardeners found that the juice of the plant irritates the eyes and causes a temporary blurring of vision ; in spite of this numerous plants are found growing as weeds in the gardens, and people who collect the flowers are warned about the harmful juice.

Interested by this information, I analysed the characters of the plant and found it to be *Laurentia longiflora* (L.) Endl. (Campanulaceae), which was first recorded in India by Fr. Santapau (1955). He recorded it as growing in wasteland at Castle Rock in North Kanara and, as an ornamental introduction in a Bombay garden. Of late it has been seen as a very common weed in many gardens in Bombay and its neighbourhood (Santapau 1964).

In the last two years the plant has spread to the adjacent gardens of the Government House and the French Institute, Pondicherry.

The following observations were made on the plants growing in the gardens of the French Institute.

The flowers are protandrous. I have not observed any biological agent in the act of effecting cross-pollination in this exotic plant ; nevertheless it is found to produce about 800-1500 seeds per capsule and *c.* 70% of the seeds are viable. The occurrence of this plant along seepage canals and the fact that the seeds float in water suggest that they are transported by the canal water.

The mature capsules are drooping (see the illustration given by Santapau 1955) and open by two loculicidal valves at the top between the persistent calyx lobes. The seeds fall in small quantities when the dry capsules are shaken by the wind, and they germinate readily in moist and shady soil and fresh seeds collected from mature capsules were found to do so in moist sawdust.

Since the plant produces flowers and fruits throughout the year, it has a large seed output and in view of the high percentage of seed viability, the reproductive capacity of *Laurentia longiflora* is remarkably great. Hence, Fr. Santapau's assessment that this weed needs watching is justified.

For a detailed botanical description and illustrations and for an account of the poisonous qualities of this plant, the following articles are recommended:

SANTAPAU, H. (1955): *Laurentia longiflora* Endl., a new record for Bombay State. *J. Bombay nat. Hist. Soc.* **53** (1): 156-157.

———————— (1964): These exotic weeds need watching. *Indian Farming* **14** (4): 20-23, 25.

TUYN, P. (1960): Laurentia. *Flora Malesiana*, ser. 1, **6** (1): 139-141.

ACKNOWLEDGEMENTS

I express my gratitude to Dr. P. Legris and Dr. V. M. Meher-Homji for their valuable suggestions.

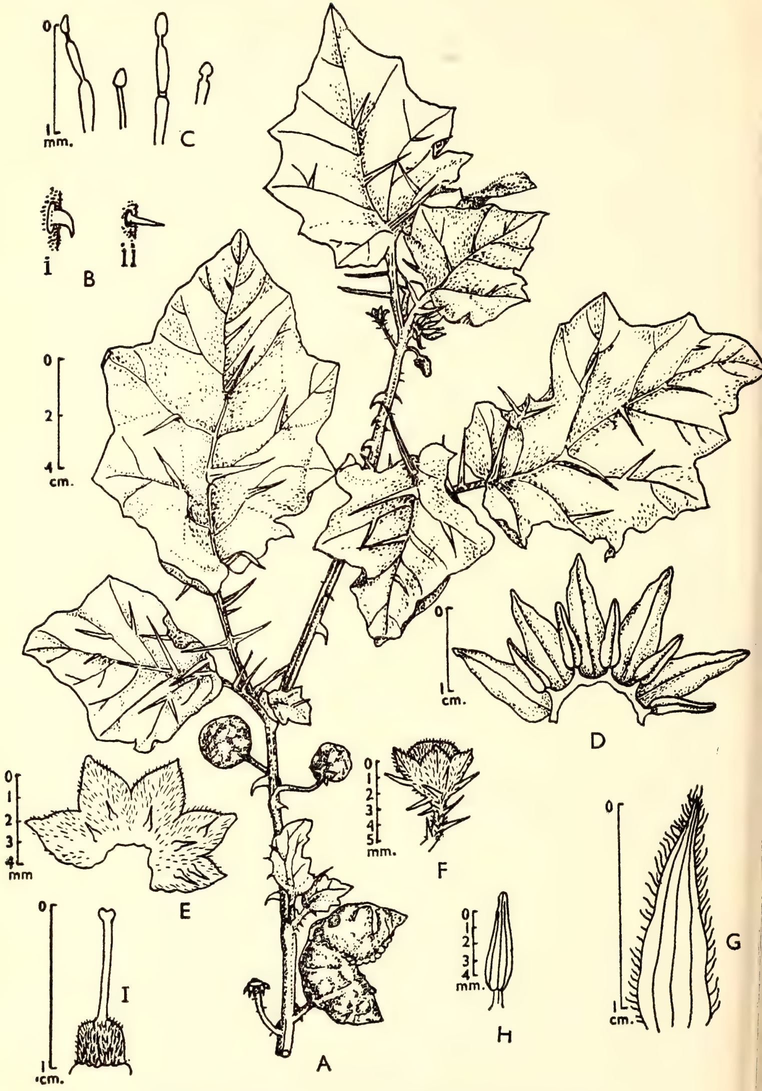
FRENCH INSTITUTE,
PONDICHERRY, G. THANIKAIMONI
May 6, 1965.

17. *SOLANUM KHASIANUM* VAR. *CHATTERJEEANUM* SEN GUPTA: THE POSSIBILITY OF A STEROID HORMONE INDUSTRY IN INDIA

(*With a plate*)

The word hormone is derived from the Greek *hormaein* which means to excite. Hormones are chemical substances secreted by endocrine glands in small quantities. Steroid hormones, mostly secreted by the cortex of the adrenals and the gonads, include cortisone, the wonder drug for rheumatoid arthritis, and the sex hormones estrone and progesterone, androsterone and testosterone.

The first steroid hormone to be isolated was estrone (Doisy *et al.* 1929) from the urine of pregnant women and, once the new field was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Solànum khàsianum var. *chàtterjeeanum* SenGupta

A. portion of the plant with flowers and fruits ; B. prickles on stem surface : i. recurved type ; ii. straight type ; C. glandular hairs ; D. corolla and stamens ; E. calyx—outer surface ; F. calyx and ovary ; G. corolla—inner surface ; H. stamen ; I. ovary and style opened up, a series of research laboratories started working with great speed. This is evident from the subsequent isolation in quick succession of natural hormones like androsterone (Butenandt 1931), progesterone (Butenandt *et al.* 1934), testosterone (David *et al.* 1935), and cortisone (Mason *et al.* 1936).

The amount of labour and skill involved in these isolations will appear from a single instance, that 625 kg. of ovaries from 50,000 sows were processed for 20 mg. of pure progesterone. Even so, the efficacy of steroid hormones particularly cortisone for human ailments was so great that labour and cost were of no consideration and a total of 1270 lb. of desoxycholic acid equivalent to 600,000 litres of ox bile was processed by Merck & Co. in 1949 to produce about 1 kg. of cortisone at a cost of $200 per gram. However, the supply of desoxycholic acid is limited by the number of cattle slaughtered and a less expensive and potentially unlimited plant source was essential. Marker *et al.* (1940) proved that steroid sapogenins are readily converted to pregnane compounds with the potential chemical framework for steroid hormones. Diosgenin and hecogenin, outstanding among steroid sapogenins, occur commonly in Dioscoreaceae, which include genus *Dioscorea,* source of diosgenin, and in certain species of *Agave* of family Amaryllidaceae, source of hecogenin. So in 1950, with authorisation and funds from the American Congress, a joint programme was initiated by three agencies, National Institute of Health (NIH), Section of Plant Introduction (SPI), and Eastern Utilization Research Branch (EURB), for increasing the cortisone supply. SPI procured raw plant materials for chemical analysis and developed promising species as crops, EURB found out potential cortisone precursors in the plant materials procured, and NIH synthesised cortisone from suitable plant steroids isolated by EURB. As a result 5320 plant samples representing 1068 genera in 219 plant families were studied, and two species of *Dioscorea* having the highest yields of diosgenin on record (8·5% and 10%) and an *Agave* giving as much as 2·5% hecogenin were discovered. The total outcome was surprising, for the cost of cortisone fell from $200 per gram in 1949 to $3·50 in 1955-58, and progesterone from $80 per gram to $0·48.

While diosgenin and hecogenin were holding the monopoly as starting materials in the manufacture of steroid hormones a serious challenge came from an alkaloid, solasodine (Sato *et al.* 1951). Its chemical structure is very close to diosgenin, from which it differs in having an imino nitrogen in place of an oxide linkage. The importance of solasodine has further increased owing to its facile conversion to progesterone with a remarkably high yield (Sato *et al.* 1959). In fact, in USSR diosgenin has been replaced by solasodine in the manufacture of steroid hormones.

Solasodine was first reported in 1905 (Oddo 1929) in the berries of *Solanum sodomeum* Linn. as a glycoside, named ‘ solanine-s ’ to distinguish it from ‘ solanine-t ’ of potato sprouts. The name was subsequently changed to solasonine (Rochelmeyer 1937) and various other names were given to the same glycoside, namely purpurine from *S. aviculare* Forst. f., solancarpidine from *S. surratense* Burm. f. (=*S. xanthocarpum* Schrad. & Wendl.), and soladulcamaridine from *S. dulcamara* Linn. — these were later merged as solasonine (Briggs *et al.* 1937, Boll 1962).

Solasodine is an alkaloid and its isolation is comparatively easy since it forms a sparingly soluble hydrochloride. It is present in berries of various species of *Solanum* which are produced throughout the year in large quantities. The cost of their collection is less than for *Dioscorea*, in which diosgenin occurs in the deeply growing underground tubers or yams.

At present the commercial production of bulk steroid hormones is most competitive, the cost of the final product mainly depending on the starting material. India being rich in native species of Solanaceae with about 33 species of *Solanum*, attempts are being made in this Department to find out a rich source of solasodine with help and financial assistance from P. L. 480.

So far we have studied twenty species of *Solanum* of which one has proved to possess the highest quantity of solasodine on record (5.4%). This has been isolated from the mature berries of *Solanum khasianum* var. *chatterjeeanum* SenGupta. The taxonomic features in which it differs from *Solanum khasianum* Clarke are : distinctly recurved prickles on stems, and glandular hairs densely aggregated on stem, leaves, pedicels, and sepals (SenGupta 1961).

The plant grows wild in the Khasi and Jaintia Hills, Lohit Division (NEFA), Sikkim, W. Bengal, Orissa, and the Nilgiris. It flowers and fruits throughout the year, specially during the summer and rainy seasons. The berries (Plate) are globose, 2·5-3 cm. in diameter, green with faint variegation turning bright yellow at maturity, usually solitary or in clusters of 2 to 3.

The solasodine contents in different parts of this plant and also in plants collected from various regions have been assayed. The results show that plants collected from the Nilgiris contain the maximum quantity of solasodine in the berries.

It may be mentioned in this connection that the identity of the plant as well as its economic potentiality have been first established by this Survey. Its physiology is now being studied to find out how the yield of solasodine can be increased.

The Development Council for Drugs and Pharmaceuticals, Government of India, has fixed a target for the production of nearly 1200 kg. of steroid hormones during the Fourth Five-year Plan period for home consumption. Besides this, there is a high demand all over the world, the USA alone consuming a single item of corticoid drugs worth 100 million dollars in 1958.

In India we have potentialities for the richest source of solasodine, with raw materials for the manufacture of steroid hormones. Let us exploit it fully and earn the foreign exchange so essential for our national development.

BOTANICAL SURVEY OF INDIA,
CALCUTTA,
March 15, 1965.

P. C. MAITY

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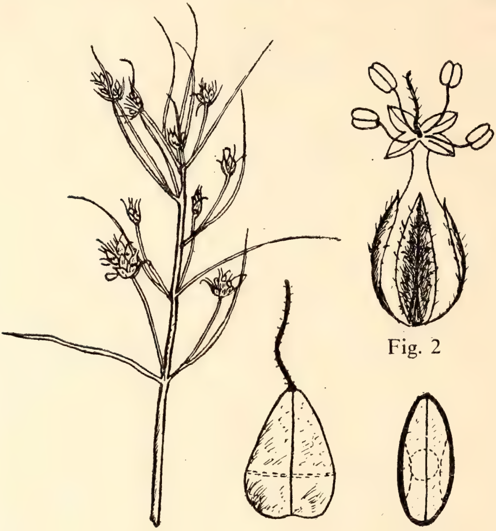
18. ON THE OCCURRENCE OF *PLANTAGO PSYLLIUM* LINN. IN GUJARAT

(*With four text-figures*)

Plantago psyllium Linn. Sp. Pl. 167, 1753; Fl. Brit. Ind. 4: 707, 1885 (excl. syn.); Kirtikar & Basu, Ind. Med. Pl. (ed. 2) 3: 2042, 1933.

Annual *herb*, erect, 30-45 cm. tall with opposite branches; stems and branches somewhat tumid at lower nodes, terete, faintly striate, olive green, finely glandular pubescent in older parts, densely so in younger. *Leaves* 2·5-6·5 cm. long, opposite or subopposite, apparently appearing whorled, narrowly linear, glabrous except a few hairs on margins near base, subacute or obtuse at apex, sheathing at base; sheath of opposite leaves sometimes united. *Spikes* 6-10 mm. long, ovoid or oblong, compact, solitary, axillary, on 2·5-5 cm. long, glandular hairy peduncle. *Flowers* rosy pink. *Bract* 5-10 mm. long, glandular hairy. *Sepals* 4, 2·5-3 × ± 1 mm., ovate, acute or subacute, pubescent on outer side, with hyaline, ciliate margins. Petals 4, united, glabrous; tube 3·5-4 × 1·5-2 mm., somewhat constricted beneath lobes; lobes ± 1 mm. long, ovate, acute. *Stamens* 4, exserted; filaments slender, glabrous; anthers yellow when fresh, pale brown on drying. *Ovary* 2 × 1·5 mm., glabrous; style 2·5-3 mm., slender, hairy, in fruit pale brown. *Fruit* 3 × 2 mm., glabrous, circumsciss a little below the middle. *Seed* 3 × 1·3 mm., yellowish brown, glabrous, boat-shaped.



Plantago psyllium Linn.

Fig. 1. Twig (× 0.75); Fig. 2. Flower × 7.5; Fig. 3. Fruit × 7.5; Fig. 4. Seed × 7.5.

Collected on 1.2.1965 from cultivated fields of *Cuminum cyminum* L., about three miles from Vallabh Vidyanagar, where it is common in some fields (*Shah* 11380, five sheets).

From the literature available to the authors, it appears that the plant has not been recorded previously from Gujarat and Maharashtra States. It is reported here for the first time.

ACKNOWLEDGEMENT

The authors are deeply thankful to Shri M. B. Raizada, Principal, D.A.V. College, Dehra Dun, for confirming the identity of this plant.

UNIVERSITY DEPARTMENT OF BOTANY,
S. V. VIDYAPEETH,
VALLABH VIDYANAGAR,
DIST. KAIRA, GUJARAT STATE,
March 30, 1965.

J. G. CHOHAN, M. SC.
G. L. SHAH, M.SC., PH.D.

19. *JATROPHA TANJORENSIS* ELLIS ET SAROJA : A NEW RECORD FOR EASTERN INDIA

This species was recently described from south India by Ellis & Saroja (1962) in *J. Bombay nat. Hist. Soc.* **58**(3) : 834-836. As it is so far not recorded from any other part of the country, its occurrence in W. Bengal is of interest. The author collected this plant at Panpur, Howrah District, on 4 May 1964 ; some full grown plants, 1·5-3 m. high, in a fence and some smaller ones scattered on open places near by. Since the plant is used for fencing one can expect that in the near future this may be spread widely by human agency.

J. tanjorensis is closely allied to *J. glandulifera* Roxb., but can be easily distinguished in the field by its leaves lobed above the middle, and its finely serrated margins, with each serrature gland-tipped. The wide range of its flowering season is clearly evident from the date of collection of the type (20 Jan. 1961) and the present collection.

Specimens examined *Bennet* 704. CAL.

Thanks are due to Dr. S. K. Mukerjee, Keeper, Central National Herbarium, for encouragement and to Mr. J. L Ellis, Botanist, Botanical Survey of India, Coimbatore, for confirming the identity of the specimen with the type.

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
BOTANIC GARDEN P. O.,
HOWRAH,
March 16, 1965.

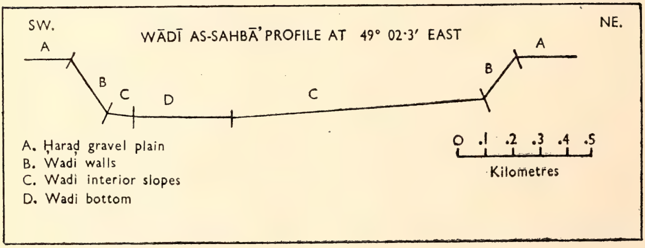
S. S. R. BENNET

20. NOTES ON THE VEGETATION OF WĀDI AS-SAHBĀ', EASTERN ARABIA

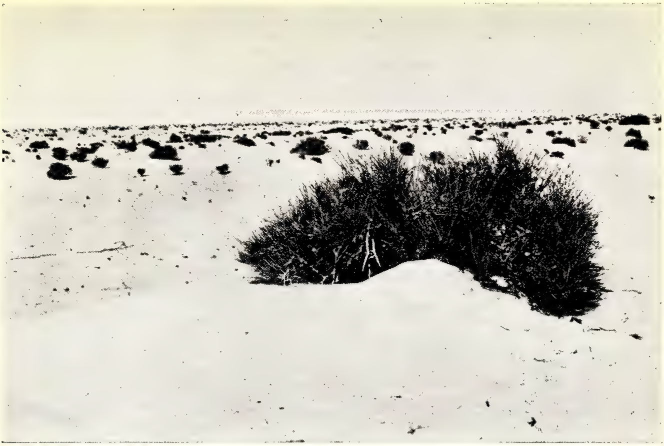
(*With a diagram and two plates*)

On 10-11 February 1965 the writer made several traverses through the Ḥaraḍ (Haradh)-Central Jāfūrah area of eastern Saudi Arabia to gather field data for a vegetation map of the Eastern Province. Part of the route lay in Wādī as-Sahbā', and the following qualitative notes on the natural vegetation of the wadi may be of some interest, now that the area has been selected as the site of a major agricultural development project.

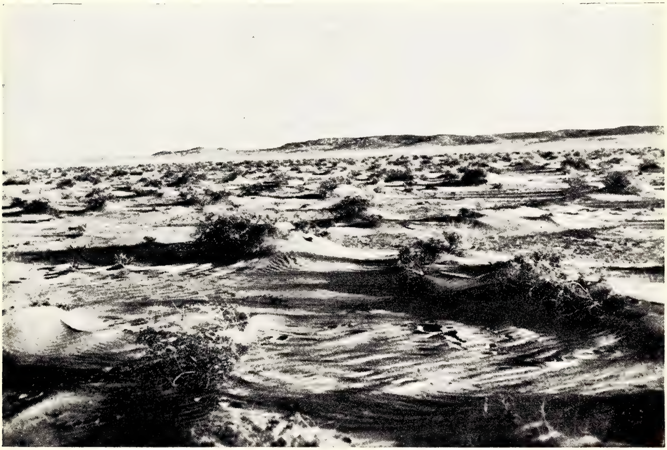
The writer and a companion entered the wadi near the new project site, camped in the wadi bed to the south-east, and drove down the channel the next day to a little beyond the point where it is blocked by dunes of the Jāfūrah, near longitude 49° 30′ east. At about 49° 02·3′ east, or 8 km. south-east of the project site, a vegetation transect of the wadi was made (see diagram below) with exaggerated vertical scale. The vegetation data gathered here are fairly representative of most of the wadi's length. At this point the wadi bottom, or *sayl* bed, runs near the southern bank. At other points it is nearer the centre or the northern bank. The wadi cross-section may, for purposes of description, be divided into four zones :



A. *The Ḥaraḍ gravel plain.* This is an extensive, nearly level plain with a surface of water-deposited pebbles and cobbles derived from the Pleistocene flow of the Sahbā' channel. The vegetation of this plain is very sparse ; in the Ḥaraḍ area it consists of occasional stunted shrubs of *Rhanterium epapposum* Oliv. (Arabic : 'arfaj) with clumps of *Rhazya stricta* Decne. (Arabic : ḥarmal). About 32 km. north-east of Ḥaraḍ the *Rhanterium-Rhazya* gives way to a well-defined association of co-dominant *Rhanterium* and *Ephedra alata* Decne. (Arabic : ' alandá). *Diplotaxis harra* (Forssk.) Boiss. (Arabic: khafsh), *Astragalus dactylocarpus*

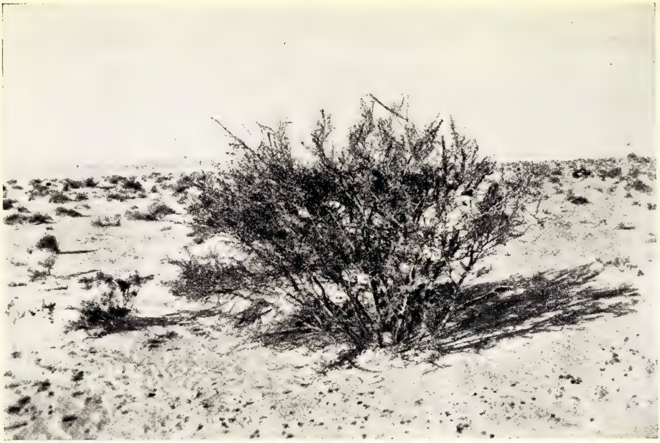


1. *Ephedra alata* Decne. (0·75 m.) in the *Rhanterium-Ephedra* association of the northern Harad gravel plain (24° 28′ N.; 49° 23′ E.). *Ephedra*, commercially exploited in some countries as a source of the drug ephedrine, occurs here with *Rhanterium* on small hummocks on the light, gritty soil characteristic of this community.



2. Wādī as-Sahbā' bottom (24° 02·5′ N.; 49° 02·2′ E.), with hummocks of the dominant shrub *Haloxylon salicornicum* in winter resting stage. In the background, the nearly barren interior slopes and the northern wall.

(*Photos : James P. Mandaville, Jr.*)



1. *Acacia flava* (2·5 m.), characteristic of the *Haloxylon* bottom community in Wādī as-Sahbā' (23° 57′ N. ; 49° 14′ E.)

2. Wādī as-Sahbā' bottom inside the western edge of the Jāfūrah dunes (23° 50′ N. ; 49° 30′ E.). The shrublets on the wadi floor are *Haloxylon* and co-dominant *Anabasis setifera*.

(*Photos : James P. Mandaville, Jr.*)

Boiss. and *Daemia cordata* R. Br. (Arabic: ghalqah) were noted in *sayl* channels cutting across the plain from the Ghawār hills at a point 16 km. north-east of Ḥaraḍ. The eastern portion of the plain along the edge of the Jāfūrah dunes immediately north of Wādī as-Sahbā' supports very sparse and stunted shrublets of *Haloxylon salicornicum* (Moq.) Bge. (Arabic: rimth) rather than *Rhanterium*. A few shallow basins in this area had a fairly dense cover of *Monsonia nivea* (Decne.) J. Gay (Arabic: qarnuwah). Travelling north along the edge of the Jāfūrah, it was noted that scattered *Rhanterium* again became evident north of latitude 24° 10′ north, and at 24°24′ north the denser *Rhanterium-Ephedra* association of the northern Ḥaraḍ gravel plain was entered (Plate I, 1). The plain south of Wādī aṣ-Sahbā' was not studied.

B. *The wadi walls.* The wadi walls are quite steep, in some places having the aspect of small bluffs. Run off from the gravel plain attains enough velocity to cut deep channels to the valley floor. Vegetation on the walls is generally confined to these water channels and consists of well-developed *Rhanterium*, *Anvillea garcini* (Burm.) DC. (Arabic: nuqd), and tussocks of the grass *Lasiurus hirsutus* (Forssk.) Boiss. (Arabic: ḍa'ah).

C. *The wadi interior slopes.* The interior slopes, like the walls, are generally barren except where cut by water channels. The rate of run-off in this zone is less, however, and the vegetation attains a greater development. This is particularly true of the northern slope, where sand has blown over the wall to form drifts covered and stabilized by *Lasiurus* and *Panicum turgidum* Forssk. (Arabic: thumām), with frequent shrubs of *Lycium barbarum* L. (Arabic: 'awsaj) and *Ochradenus baccatus* Del. (Arabic: qurḍī).

D. *The wadi bottom.* This zone is quite level and of variable width, averaging perhaps 350 metres. *Haloxylon salicornicum* is the obvious dominant, occurring in relatively closely spaced hummocks that mark the limits of the zone (Plate I, 2). The other conspicuous member of the community is a small tree, *Acacia flava* Schweinf. (Arabic: salam), that overtops the *Haloxylon* in a discontinuous line along the lowest part of the channel (Plate II, 1). Infrequent examples of *Lycium* and *Rhanterium* were also seen 12 km. south-east of the Jabrīn track crossing.

Probably the most abundant annual of the bottom community is *Neurada procumbens* L. (Arabic: sa'dān), which in some favourable locations forms mats of almost continuous cover. Other annuals noted in the silty bottom among the *Haloxylon* were: *Arnebia decumbens* Coss. et Kral. (Arabic: kaḥal), *Plantago ciliata* Desf. (Arabic: yanam), *Senecio coronopifolius* Desf. (Arabic: kurā' al-ghurāb), *Sclerocephalus arabicus* Boiss., *Emex spinosa* Camped. (Arabic: ḥambizān), *Koelpinia* *linearis* Pall. (Arabic : liḥyat ash-shaybah), *Trigonella stellata* Forssk. (Arabic : nafal), *Astragalus* sp. cf. *tribuloides* Del. (Arabic : qafʿā'), and *Diplotaxis harra*. *Anastatica hierochuntica* L. (Arabic : kaftah) was abundant.

Nearer the Jāfūrah dunes there is a gradual increase in drift sand cover on the wadi floor. *Acacia* becomes infrequent, and the *Haloxylon* shrubs are more widely spaced. As the first isolated dunes appear, *Anabasis setifera* Moq. (Arabic : shaʿrān) becomes co-dominant with *Haloxylon* in the flats (Plate II, 2).

Haloxylon salicornicum in Eastern Arabia is usually characteristic of areas with a relatively high water table and poorer drainage. The Wādī as-Sahbā' bottom is certainly somewhat more saline than the walls or the plain above, but the presence of such a variety of annuals and the absence of definite salt markers such as *Seidlitzia rosmarinus* (Ehrnb.) Solms.-Laub. (Arabic : shinān) and *Suaeda vermiculata* Forssk. (Arabic: sawwād) indicate that this bottom salinity is moderate. The presence of *Anabasis* further down the wadi may indicate increasingly saline conditions in the lower reaches of the channel.

A large scale Bedouin settlement programme in Wādī as-Sahbā' would probably result in the eradication of the *Acacia* now found in the wadi bed as well as most of the *Haloxylon*, a highly valued fuel shrub in any area of such sparse vegetation. Except where portions of the channel are cleared for cultivation, it might be worthwhile to maintain the *Haloxylon* cover to help control seasonal run-off.

Another sampling of the wadi's flora in late spring would certainly add to the list of annual plants; annual grasses were notably absent in early February. Some quantitative vegetation data would be useful, and any time spent examining the potentially destructive rodent fauna of the wadi would not be wasted. Jerboas (*Jaculus* sp.) and gerbilles (*Gerbillus* sp.) were observed in the *Haloxylon* community at night; and sand rats of the genus *Meriones*, if present or introduced, might prove to be particularly troublesome as crop destroyers.

ARMACO, BOX 1912,
DHAHRAN,
SAUDI ARABIA,
March 1, 1965.

J. MANDAVILLE

21. A NOTE ON THE IDENTIFICATION OF SOME UNRECORDED DESERT PLANTS FROM KUTCH

While studying the plants of the Indian Desert at the Blatter Herbarium, St. Xavier's College, Bombay, the author came across certain interesting but little known plants from the district of Kutch. These plants were either wrongly assigned or were found in the *dubia* covers.

None of them has been reported earlier from Kutch (Blatter 1908 ; Cooke 1901-1908 ; Hooker 1872-1879 ; Thakar 1926 ; Jain & Deshpande 1960 ; Jain & Kanodia 1960 ; Kapadia 1954 ; Palin 1880 ; and Saxton & Sedgwick 1918) and most of them not even from the adjacent regions of Saurashtra (Santapau 1953, 1962 ; Santapau & Raizada 1954, 1955). It was, therefore, considered desirable to place on record the occurrence of these species in the Kutch region, which has great phytogeographical importance as it is the meeting ground of the arid elements of the African and Arabian flora with those of the Indian flora. The geographical distribution of these species is interesting.

All the specimens are deposited in the Blatter Herbarium.

1. **Cleome brachycarpa** Vahl ex DC. Prodr. 1 : 240 ; 1824.

Irani 5225, 5226, and 5227 : 'Jalender-Bet, 8-9-60. Erect, 1½ ft. high ; much branched from the base ; forming a clump ; about 1 ft. in diameter ; in flower (yellow) and fruit ; occasional in open ; locally abundant along road sides.'

This species has been reported only from NW. Rajasthan in India ; it is a common species in West Pakistan, Arabia, Abyssinia, and N. Africa.

2. **Corallocarpus conocarpus** (Dalz. ex Dalz. & Gibs.) C. B. Clarke in Hook. f. Fl. Brit. Ind. 2 : 628 ; 1879.

Irani 5184, and 5185 : 'Rest House, Juiju-Wada, 7-9-60. Climbing on *Capparis aphylla* in the open ; leaves fleshy ; fruits green when young, red with age ; leaves eaten as vegetables ; local name : "*Kadavi-Nai*".'

A very rare species, recently reported (Bhandari 1963) as a new record for NW. Rajasthan. Earlier this species was collected by Dalzell from Gujarat (no definite locality given) ; by Stocks, probably from Sind, and by Talbot from 'Dumbal'.

3. **Dactyliandra welwitchii** Hook f. in Fl. Trop. Afr. 2 : 557, 1871 ; Bhandari et Singh in Kew Bull. 19 : 133. 1964.

Irani 5198 : 'Kutch, 8-9-60. Climber, in flower (Whitish-green) and fruit ; seeds 6-8 ; the auriculate stipules are very conspicuous ; vernacular name : *Anj-phutamni*'. *Irani* 5244 : 'Jalender-Bet, 9-9-60 Climber, in fruit; bracts conspicuous ; common ; vernacular name *Ankh-phutamani*.'

Recently reported as a new genus record for India (Bhandari & Singh 1964), this species was known earlier only from Angola and south-west Africa (Meeuse 1962).

Irani's specimens were lying in the *dubia* cover of Cucurbitaceae at Blatter Herbarium until they were assigned by the author.

4. **Hibiscus punctatus** Dalz. ex Dalz. & Gibs. Bomb. Fl. 20. 1861.

Irani 5253 : 'Kutch, Jalender-Bet, 12-9-60. An erect undershrub 1-2 ft. high ; in flower ; occasional ; identified as one of the *Malvaceae*.'

This species has so far been reported from Saurashtra (Jamnagar and Okhamandal) and NW. Rajasthan (Bhandari 1963).

5. **Merua arenaria** var. **glabra** Hook. f. & Thom. in Fl. Brit. Ind. 1 : 171. 1872.

Irani 5245 and 5246 : 'Jalender-Bet, Kutch, 9-9-60. Is it a liana ? The basal portion of the stem is very thick, twines for about 6 ft. and gives out sarmentose drooping branches ; in bud ; very common. It was also very common towards the West but in leaf only; vernacular name : *Batakna*.'

Identified as *Cadaba indica.*

Young plants of this species from NW. Rajasthan have posed problems to the author as to their identification but the difficulty was solved later when similar young branches were observed growing from the base of some old plants in the same region. This plant has recently been reported from Saurashtra (Santapau 1962).

6. **Tephrosia uniflora** subsp. **uniflora** Gillett in Kew Bull. 1958 : 114.1958.

Irani 5216 and 5217 : 'Kutch, Jalender-Bet, 8-9-60. Erect 1-2½ in. in fruit, on dry sloping ground, locally abundant but not common.'

Subsp. **uniflora** is a common plant in the drier parts of tropical Africa. It is separated from the subspecies *petrosa*, which is very common throughout NW. Rajasthan and Ajmer, by its more or less spreading indumentum, leaflets often up to 7 (sometimes 9), seeds 9-14, and pods 5-6 cm. long. The subspecies *petrosa* on the other hand has the indumentum of pods, pedicels, and calyx closely appressed, the leaflets very rarely more than 5, seeds 5-8 (rarely 9), and pods 3-5 cm. long.

This is the first record of this subspecies from India.

7. **Tephrosia uniflora** subsp. **petrosa** (Blatt. & Hall.) Gillett et Ali in Kew Bull. 1958 : 114. 1958.

Irani 5215 : 'Kutch, Jalender-Bet, 8-9-60. In fruit ; on dry sloping grounds ; locally abundant but not common.' *Irani* 5373 (12-9-60) and 5338 (11-9-60) 'Vernacular name : *Jhill* ; Jalender-Bet, Kutch.' SAURASHTRA : *Santapau* 14597 : '*T. pauciflora*, Rajkot, Praduma Park, 20-8-52 ; flowers purple, on slopes forming cushions'. *Bole* 612 : 'Plants poor but most probably this is not *T. senticosa* ; Jila Garden, Rajkot ; 20-8-52, herb ; flowers red, frequent.'

This subspecies has been reported by Gillett (loc. cit.) from Hedjaz, Aden, W. Pakistan (Sind and NW. Frontier Province), and in India it has up till now been found only in NW. Rajasthan and Ajmer.

ACKNOWLEDGEMENTS

The author is indebted to Prof. P. V. Bole, St. Xavier's College, Bombay, for providing facilities to work at Blatter Herbarium and to Fr. H. Santapau for offering valuable comments.

BOTANY DEPARTMENT,
UNIVERSITY OF JODHPUR,
JODHPUR, RAJASTHAN,
December 5, 1964.

M. M. BHANDARI

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1964-65

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1964

At the last Annual General Meeting of the Society held on 28th April 1964 we presented a supplementary report about the activities of the Society up to April 1964, and the present report covers the eight months thereafter up to 31st December 1964.

THE SOCIETY'S JOURNAL

Two numbers of the *Journal*, Vol. 61, No. 1 and No. 2, were published during the period under report. The 481 pages include 7 papers on botany, 5 on insects, 4 on birds, 2 each on reptiles, fishes, and Crustacea and 1 each on wild life, mammals, and molluscs. The 45 Miscellaneous Notes covered many subjects and, together with the papers, included descriptions of several new species and races of various animals and plants. It is unfortunate that the publication of the *Journal* numbers is often delayed considerably, but the editors are making every effort to hasten publication.

GENERAL

BNHS/WHO Bird Migration Study Project. Two camps were held during the period under report. At the camp held at Hingolgadh, Saurashtra, 335 birds were ringed between 18th and 28th September 1964, and blood samples collected. The second camp at Manjhaul, Bihar, ringed 2677 birds of 27 species between 18th November 1964 and 20th January 1965. The blood samples collected at this and the earlier camp were sent to the Kievskae Shosse Institute of Poliomyelitis and Virus Encephalitis, Moscow, USSR, for virological investigation. We have since been informed by Prof. G. I. Netsky of the Institute that some of the samples have yielded virus anti-bodies. We received during the year reports of recoveries in Russia of 14 birds ringed by us at the various camps. The work is to be continued.

Additions to the Collections. During the year 352 additions were made to our registered collections as under :

Mammals	..	15
Birds	..	297
Reptiles	..	20
Amphibians	..	20.

Interesting additions among these are :

Mammal

Pteropus faunulus

Birds

Egretta sacra
Spilornis elgini
Gallinula chloropus orientalis
Sterna dougallii
Macropygia rufipennis
Psittacula longicauda
Centropus andamanensis
Otus balli
Ninox scutulata obscura
Collocalia inexpectata
Dendrocitta bayleyi
Coracina striata
Hypsipetes nicobariensis
Pachycephala cinerea
Nectarinia jugularis
Pericrocotus divaricata

Reptiles

Gekko smithi
Calotes andamanensis.

Research Studies. The ecology and status of the butterfly *Nacaduba pactolus continentalis* Früh., which is rare in the northern ranges of the Western Ghats, are being studied. The work is in progress.

Two projects under the scheme ' The Role of Birds in our National Economy ', sponsored by the Council of Scientific and Industrial

Research, are under study. The investigation on ornithophily is nearing completion and the study of migration is in progress.

Wild Life Preservation. (*a*) A Memorandum was submitted to the Planning Commission for strengthening the Indian Board for Wild Life and making it an effective body for the preservation of the country's natural wealth.

(*b*) A proposal was sent to the Bihar Government for converting the Kabar Tal in Monghyr District, Bihar, into a bird sanctuary for the protection of migrant birds visiting the area in winter.

(*c*) The Society's proposal for a survey of the Wild Buffalo in Bastar was accepted by the Government of Madhya Pradesh, and it has been decided to depute the Curator to visit the area and work in association with Dr. George Schaller, an American ecologist, who is already in India.

PUBLICATIONS

The 7th edition of Dr. Sálim Ali's THE BOOK OF INDIAN BIRDS was published during the year. The Society also reprinted a set of 12 picture postcards of Indian birds. Coloured plates for the Hindi edition of THE BOOK OF INDIAN BIRDS were supplied to the Central Hindi Directorate who are publishing this book. Work on the ten-volume HANDBOOK OF INDIAN BIRDS by Dr. Sálim Ali is in progress. There was a considerable amount of difficulty in clearing through the Customs the paintings for the plates which are being received from abroad and which are being financed entirely by the co-author of the book Dr. Dillon Ripley. We are considering the publication of a revised and condensed version of our popular book on angling, CIRCUMVENTING THE MAHSEER AND OTHER SPORTING FISH IN INDIA AND BURMA by A. St. J. Macdonald.

LIBRARY

During the year 124 books and bound journals were added to the library, of which 19 books were purchased, 20 received for review, and 11 presented. Our thanks are due to the donors.

NATURE EDUCATION SCHEME

The Nature Education Scheme financed by the Government of Maharashtra is now in its 17th year. Tours of the Natural History Section of the Prince of Wales Museum and special talks on natural history subjects with the aid of exhibits and specimens, films, and living animals were continued. The activities under the scheme have now been extended to Poona and the revised General Science Syllabus prepared by the Society's Nature Education Sub-Committee giving importance to the study of the natural environment has been adopted by many schools in Bombay and Poona.

TALKS AND FILM SHOWS

Five meetings were held at the Society's rooms during the period under report at which Prof. P. V. Bole spoke on 'The Valley of Flowers', Dr. T. Ramachandra Rao on 'The Natural History of Arbo-Viruses', Dr. C. V. Kulkarni on 'Fisheries Development in Maharashtra State', Mr. Zafar Futehally on 'Some Attempts at Preserving Vanishing Bird Species', and Mr. Andrew J. Berger on 'Kirkland's Warbler'. A meeting was also held in association with other organizations to felicitate Fr. H. Santapau, S.J., on the award to him of the Birbal Sahni Medal for 1963.

MEMBERSHIP

The total membership on our books at the end of 1964 was 1315, including 241 life and 4 honorary members. Subscriptions were received from 764 members, including 63 Forest Department nominees, and we hope to receive subscriptions from most of the remaining members except for a few who cannot be traced. During 1964, 78 ordinary members and 3 life members were enrolled as against 48 members who either resigned or died. We would like to enlist your help in enrolling more members. As you know, the annual subscription has remained unchanged since 1949 and, unless there is a substantial increase in membership, we will be unable to cover our deficit in the future.

REVENUE ACCOUNT

During the year the income of the Society, excluding the special grant received from the Government of Maharashtra for the maintenance of the Reference Collections and the Grant-in-aid from the Council of Scientific and Industrial Research for the Scheme on 'The Role of Birds in Our National Economy', was Rs. 57,472.42, as against Rs. 69,058.70 in the previous year. The working of the Society during 1964 showed a deficit of Rs. 10,391.20 as against Rs. 8,324.25 in 1963. The large deficit in 1964 was due mainly to the fact that our popular publications were out of print during the year.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in the United Kingdom.

SUPPLEMENTARY REMARKS BY THE HONORARY SECRETARY FOR THE PERIOD JANUARY TO APRIL 1965

GENERAL

New Building. We are glad to report that the new premises of the Society, 'Hornbill House', were formally opened on 13th March 1965 by the Honourable Minister for Education to the Government of India, Shri M. C. Chagla. A report on the function is being published in the Society's *Journal* [Vol. **62** : 185 ff.].

Research Studies. Funds have been provided from the Sir Dorabji Tata Trust grant for field work to a knowledgeable member for an ecological survey of the Hazaribagh National Park in Bihar.

Wild Life Preservation. As a result of the Memorandum submitted by the Society, the Planning Commission called a meeting for 'Wild Life Preservation' at Delhi on 23rd April 1965. It is hoped that the decisions taken at the meeting will be implemented in course of time.

The Curator, Mr. J. C. Daniel, in association with Dr. George Schaller, made a preliminary survey of the Wild Buffalo areas in Bastar in April 1965. The report is under preparation.

PUBLICATIONS

The revised second edition of Prater's THE BOOK OF INDIAN ANIMALS was published in April 1965.

LIBRARY

During the period under review, 19 books and bound volumes of journals were added to the library, of which 2 were purchased and 5 received for review.

MEMBERSHIP

In addition to the subscription received from 764 members till the end of 1964, an additional 46 members paid their subscription during this period. Efforts are continuing to induce the remaining members to pay their subscription.

Registered No. F. 244 (BOM.)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950

SCHEDULE VII [VIDE RULE 17 (1)]

BALANCE SHEET AS AT 31 *DECEMBER* 1964

FUNDS AND LIABILITIES		Rs. P.	Rs. P.
Trust Fund or Corpus :			
Life Membership Fund			
Balance as per last Balance Sheet..		76,395.28	
Add : Amount received during the year		1,140.00	77,535.28
Fixed Assets Fund :			
Balance as per last Balance Sheet ..		51,902.51	
Additions during the year ..		2,000.00	
		53,902.15	
Less : Depreciation adjusted ..		7,942.89	45,959.62
Other Earmarked Funds :			
Field Work Fund			
Balance as per last Balance Sheet	3,599.14		
Add : Amount received during the year ..	3,000.00		
	6,599.14		
Less : Spent during the year	3,200.00	3,399.14	
Wild Life Fund			
Balance as per last Balance Sheet	101.43		
Less : Spent during the year	100.00	1.43	
Carried forward ..		3,400.57	1,23,494.90

ASSETS		Rs. P.	Rs. P.
Immovable Properties			nil
Motor Car			
Balance as per last Balance Sheet ..		12,392.00	
Less : Depreciation during the year ..		2,478.40	9,913.60
Furniture, Fixtures & Equipment :			
Balance as per last Balance Sheet ..		40,343.63	
Additions duringthe year ..		3,372.30	
		43,715.93	
Less : Depreciation during the year ..		5,464.49	38,251.44
Investments : (At cost)			
14,000 4% Bombay Port Trust Bonds ..	10,780.00		
5,000 4% Bombay Improvement Trust Bonds	3,800.00		
36,000 3% Funding Loan 1966/68 ..	35,812.62		
25,000 3% Conversion Loan 1946	25,000.00		
80,000 Carried forward..	75,392.62		
Carried forward ..			48,165.04

BALANCE SHEET AS AT 31 DECEMBER 1964—(*continued*)

FUNDS AND LIABILITIES		Rs. P.	Rs. P.
Brought forward ..		3,400.57	1,23,494.90
Other Earmarked Funds—(Contd.) ..			
Expedition Fund			
Balance as per last Balance Sheet	1,800.00		
Less : Spent during the year	1,414.00	386.00	
Mammal Survey Fund			
Balance as per last Balance Sheet	171.29		
Less: Spent during the year	12.75	158.54	
Building Fund			
Balance as per last Balance Sheet		30,000.00	
Publication Fund			
Balance as per last Balance Sheet		30,725.00	
Staff Welfare Fund			
Amount received during the year		500.00	
Unspent Grant Government of Maharashtra			
1961-62 Unspent Balance B/F	348.75		
Less: Refund to Government during the year ..	348.75		
1963-64 Unspent Balance B/F ..	14,132.03	..	
Less: Spent during the year (as per Income and Expenditure Account) .	12,058.64		
Carried forward ..	2,073.39		
Carried forward ..		65,170.11	1,23,494.90

	ASSETS			Rs. P.	Rs. P.
	Brought forward ..				48,165.04
	Investments (At cost)—(Contd.) ..				
Rs. 80,000	Brought forward		75,392.62		
2,000	3% 1st Development Loan 1970/75.		1,948.75		
Rs. 82,000			77,341.37		
	(Market Value Rs. 70,883.00)				
Rs. 3,000	12 Years National Defence Certificates		3,000.00		
85,000			80,341.37		
£470	4½% Defence Bonds 2nd issue At Cost		6,266.67		
			86,608.04		
	Less: Provision for Depreciation		3,750.00		82,858.04
	Loans: (Unsecured)	*Good*	*Doubtful*		
	Loan Scholarship	Nil	Nil		
	Other Loans (to Staff)	Nil	Nil		
	Advances:				
	To Trustees	Nil	Nil		
	,, Employees (WHO Bihar Trip)	3,979.27	..		
	,, WHO (for Aluminium Bird Rings)	1,900.00	..		
	,, Lawyers	..			
	,, Nature Education Scheme	1,915.71	..		
	Others	173.42	..		7,968.40
	Carried forward ..				1,38,991.48

BALANCE SHEET AS AT 31 DECEMBER 1964—(*continued*)

FUNDS AND LIABILITIES		Rs. P.	Rs. P.
Brought forward ..		65,170.11	1,23,494.90
Other Earmarked Funds—(Contd.)			
Unspent Grant Government of Maharashtra—(Contd.)			
Brought forward ..	2,073.39		
Less : Refunded to Government during the year ..	2,073.39	..	
1964-65 Grant for the year	44,742.40		
Less : Spent during the year (as per Income & Expenditure Account) ..	29,882.46	14,859.94	
Unspent Grant World Health Organization			
Balance as per last Balance Sheet	17,761.03		
Add : Amount received during the year ..	9,524.00		
	27,285.03		
Less : Utilized during the year	10,370.26	16,914.77	
Carried forward ..		96,944.82	1,23,494.90

ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,38,991.48
Stocks: (At cost or under)		
Books and Publications ..	15,497.88	
Accumulated cost of Books under publication (Animal Book 2nd Edition & Book of Indian Birds 7th Edition)	19,088.01	34,585.89
Income Outstanding:		
Rent	..	
Interest (Accrued)	1,223.20	
Other Income:		
Supplies and Services ..	16,035.24	
Government of Maharashtra Education Activity Grant 1964-65	4,000.00	
Government of Maharashtra Maintenance Grant 1964-65	44,742.40	
Government of India Grant for Journal Expenses 1964-65	10,000.00	76,000.84
Carried forward ..		2,49,578.21

BALANCE SHEET AS AT 31 *DECEMBER* 1964—(*continued*)

FUNDS AND LIABILITIES		Rs. P.	Rs. P.
Brought forward ..		96,944.82	1,23,494.90
Other Earmarked Funds—(Contd.)			
Grant Government of India (Unspent) (for the publication of HANDBOOK OF INDIAN BIRDS in five volumes)			
Balance as per last Balance Sheet	28,000.00		
Less: Spent during the year	2,250.00		
		25,750.00	
Loans (unsecured):			
Loans from Prince of Wales Museum of Western India for the publication of Animal Book, 2nd Edition			
Balance as per last Balance Sheet ..		25,000.00	
Council of Scientific and Industrial Research Grant:			
1963-64 Unspent Balance Brought forward ..	2,408.15		
Less: Spent during the year (as per Income and Expenditure Account) ..	2,027.21		
	380.94		
Less: Transferred to a separate Bank Account..	380.94		
		..	
Carried forward ..		1,47,694.82	1,23,494.90

ASSETS	Rs. P.	Rs. P.
Brought forward ..		2,49,578.21
Cash and Bank Balances:		
(*a*) In Account with		
National & Grindlays Bank Ltd., Bombay	1,059.73	
National & Grindlays Bank Ltd., London £ 194-10-8	2,593.78	
Chartered Bank, Bombay ..	316.47	
In Fixed Deposit with:		
National & Grindlays Bank Ltd., Bombay	15,000.00	
Chartered Bank, Bombay ..	20,000.00	
(*b*) With the Trustees	..	
(*c*) With the Cashier	359.83	
		39,329.81
Carried forward ..		2,88,908.02

BALANCE SHEET AS AT 31 *DECEMBER* 1964—(*continued*)

FUNDS AND LIABILITIES		Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,47,694.82	1,23,494.90	Brought forward ..		2,88,908.02
Other Earmarked Funds—(Contd.)				*Income and Expenditure Account*		
Liabilities				Balance as per last Balance Sheet ..	12,293.24	
For Expenses ..	34,316.62			*Add :* Deficit as per Income and Expenditure Account	10,391.20	22,684.44
,, Advance Subscriptions	730.00					
,, Advance for the Supply of Animal Book, 2nd Edition ..	1,050.14					
,, Sundry Credit Balances	4,305.98	40,402.74	1,88,097.56			
Total ..			3,11,592.46	Total ..		3,11,592.46

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Property and/Assets of the Trust.

As per our report of even date

(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY, 1*st June*, 1965

Registered No. F. 244 (BOM.)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1964

EXPENDITURE	Rs. P.	Rs. P.
To Expenses in respect of properties :		
Rates, Taxes, Cesses, Repairs, and Maintenances		nil
Salaries		nil
Insurance		nil
Depreciation (by way of provision or adjustments)		nil
,, *Expenditure from Grants from Government of Maharashtra :*		
For 1963-64 : Salaries	4,712.04	
Rent	5,346.60	
Furniture ..	2,000.00	
		12,058.64
For 1964-65 : Salaries	13,842.66	
Rent	16,039.80	
		29,882.46
,, *Expenditure from Grants of Council of Scientific & Industrial Research :*		
For 1963-64 : Salaries	1,395.00	
Miscellaneous ..	632.21	
		2,027.21
Carried forward ..		43,968.31

INCOME	Rs. P.	Rs. P.
By Rent :		
Accrued	nil	
Realized	nil	
		nil
,, *Interest* (Accrued and Realized)		
On Securities	3,108.07	
,, Bank Account	1,428.22	
		4,536.29
,, *Dividends :*		nil
,, *Donations :*		
In cash	1,000.00	
In kind	—	
		1,000.00
,, *Grants :*		
Government of Maharashtra :		
For 1963-64 (Expended as per contra)	12,058.64	
For 1964-65 (Expended as per contra)	29,882.46	
For Educational Activity 1964-65	4,000.00	
Government of India :		
For Journal Expenses for 1964-65	10,000.00	
Carried forward ..	55,941.10	5,536.29

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1964—(continued)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..		43,968.31	Brought forward ..	55,941.10	5,536.29
To Establishment Expenses : ..			*By Grants*—(Contd.)		
Salaries (Including Dearness Allowance)	35,785.32		*Council of Scientific & Industrial Research :*		
Society's contribution to Staff Provident Fund	2,142.04		For 1963-64 (expended as per contra)	2,027.21	57,968.31
Postages	1,400.11		,, *Income from Other Sources :*		
Printing and Stationery	1,208.57		Subscriptions	22,282.47	
Advertisement	116.29		Entrance Fees	395.00	
Telephone charges	606.70				22,677.47
Bank charges	226.60		,, *Publications :*		
Electric charges	514.42		Journal Sales	5,794.14	
Meeting expenses	770.03				
Motor Car charges account ..	592.63		,, *Books etc. profits :*		
Conveyance and Travelling expenses..	287.07		Book of Indian Birds ..	2,834.67	
		43,649.78			
,, Remuneration to Trustees ..	nil		Some Beautiful Indian Climbers and Shrubs	663.00	
Remuneration (In the case of Math)	nil		Some Beautiful Indian Trees ..	709.36	
Legal Expenses	nil		Butterflies of the Indian Region ..	1,286.30	
Audit Fees	750.00		Synopsis of Birds of India and Pakistan	237.72	
Contribution and Fees	nil				
		750.00	Game Birds of India Vol. III ..	12.30	
,, *Amounts Written off :*			Indian Molluscs	161.08	
Bad Debts	nil		Identification of Indian Butterflies, by Evans	94.50	
Loan Scholarships	nil		Identification of Poisonous Snakes	894.85	
Irrecoverable Rent	nil		Other Publications	282.20	
Other Items	nil		Nature Calendars	2,599.97	
		nil			
Carried forward Rs. ..		88,368.09	Carried forward Rs. ..	15,570.09	86,182.07

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1964—(*continued*)

EXPENDITURE		Rs. P.	Rs. P.
Brought forward ..			88,368.09
To Miscellaneous Expenses :			
General Charges		1,361.69	
Fire Insurance		134.70	
Donation to Zoological Society of London		66.67	
,, *Depreciation :*			1,563.06
On Investments		..	
On Furniture		..	
			..
, *Expenditure on Objects of the Trust :*			
(*a*) Religious		..	
(*b*) Educational		..	
Journal Expenses		22,367.84	
,, *Library Account*			
Subscription to other Societies ..	799·47		
Purchase of Books ..	395.48		
Periodical and Binding Charges	358.00		
		1,552.95	
,, *Maintenance of Reference Collections* ..		1,709.99	
			25,630.78
Total ..		..	1,15,561.93

INCOME	Rs. P.	Rs. P.
Brought forward ..	15,570.09	86,182.07
By Books etc. profits—(Contd.) ..		..
Less : Packing and forwarding charges	327.93	
		15,242.16
,, *Miscellaneous receipts*		1,900.00
,, Profit on Investment matured ..		1,846.50
,, Deficit carried to Balance Sheet ..		10,391.20
Total ..		1,15,561.93

As per our report of even date

(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants

BOMBAY, 1st *June*, 1965

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 *December* 1964

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS		Rs. P.
To Balance as at 1st January 1964 Brought forward :			By Balance brought forward being advance from Bombay Natural History Society ..		4,285.41
Cash with Cashier	50.00		,, Salary of Nature Education Organiser ..		5,640.00
Balance with National & Grindlays Bank Ltd., Bombay, on Current Account	248.03		,, Postages		250.02
		298.03	,, Printing and Stationery		175.03
,, Grant—Government of Maharashtra 1963-64		7,640.00	,, General charges		1,025.49
,, Sales of Booklet No. I	480.09		,, Cost of Booklet No. V		652.75
,, Sales of Booklet No. II	182.06		,, Balance as at 31st December 1964 :		
,, Sales of Booklet No. III ..	313.05		Cash with the Cashier	46.80	
,, Sales of Booklet No. IV ..	407.40		With National & Grindlays Bank Ltd., Bombay, on Current Account ..	130.53	177.33
,, Sales of Booklet No. V ..	646.80				
		2,029.40			
,, Sale of Nature Study Pamphlets and Line Drawings		12.89			
,, Sales of Science Syllabus Notes ..		310.00			
,, Balance carried forward being advance from Bombay Natural History Society		1,915.71			
Total ..		12,206.03	Total ..		12,206.03

BOMBAY, 1*st* *June*, 1965

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY NATURAL HISTORY SOCIETY

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH GRANT-IN-AID FOR THE SCHEME ON THE ROLE OF BIRDS IN OUR NATIONAL ECONOMY

Receipt and Payment Account for the period from 1 *April to* 31 *December*, 1964

RECEIPTS	Rs. P.	PAYMENTS	Rs. P.
To Balance as at 1st April 1964			
Brought forward:	380.94	By Salaries	4,340.45
,, Grant for the year 1964-65	6,851.74	,, Miscellaneous Expenses	627.61
,, Interest on Bank Account	42.00	,, Balance as at 31-12-1964 with National & Grindlays Bank Ltd., Bombay, on Savings Account	2,306.62
Total ..	7,274.68	Total ..	7,274.68

BOMBAY, 1*st* *June*, 1965

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY NATURAL HISTORY SOCIETY

STATEMENT OF INCOME AND EXPENDITURE WITH RESPECT OF THE PUBLICATION OF JOURNAL FOR THE YEAR ENDED 31 *DECEMBER* 1964

PAYMENTS	Rs. P.	RECEIPTS	Rs. P.
		By Publication :	
To Establishment Expenses :		Journal Sales	5,794.14
1/3 of Salaries including Dearness Allowance, Society's contribution to Staff Provident Fund, Postages, Printing and Stationery, Advertisement, Telephone Charges, Bank Charges, Electric Charges, Meeting Expenses, Motor Car Charges Account, Conveyance & Travelling Expenses ..	14,549.93	,, 1/3 *of Membership Subscriptions*	7,427.49
		,, *Grants :*	
		Government of India for publication of Journal, 1964-65	10,000.00
1/3 of Audit Fees	250.00		
,, *Miscellaneous Expenses :*			
1/3 of General Charges, Fire Insurance, etc.	521.02		
1/3 of Library Expenses, Purchase of Books and Periodicals ..	517.65		
1/3 of Maintenance of Reference Collections ..	569.99		
,, *Journal Expenses*	22,367.84		
Total ..	38,776.43	Total ..	23,221.63

As per our report of even date

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY, 11*th June*, 1965

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, APOLLO STREET, BOMBAY 1, ON FRIDAY, 30TH JULY 1965, AT 6 P.M., WITH DR. SÁLIM ALI, D.SC., F.N.I., IN THE CHAIR

The Chairman referred to the loss the Society has sustained during the year by the deaths of:

Hamid A. Ali (Life member; joined 27-9-1912)
H.H. The Maharaja of Bhavnagar (Life member; joined 7-1-1930)
Framroze A. Daver (Joined 28-3-1923)
H. Dayal (Joined 3-1-1950)
Maj.-Gen. M. Hayaud-Din (Life member; joined 14-2-1945)
H.H. The Maharaja Yeshwantrao Holkar (Life member; joined 12-5-1930)
C. S. Kooi (Joined 24-2-1951)
Dato Loke Wan Tho (Life member; joined 26-10-1941)
K. P. Reynolds (Joined 10-6-1932)
H.H. The Maharaja of Sangli (Life member; joined 8-4-1911)
Lt.-Col. R. B. Seymour-Sewell (Life member; joined 8-10-1910)

who were all of much assistance in furthering the interests of the Society. Everyone present stood in silence for two minutes as a mark of respect.

1. The Honorary Secretary's reports for the year ending 31st December 1964 and for the period January to April 1965 having been previously circulated to members were taken as read and were adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The following were chosen as members of the Executive and Advisory Committee for the year 1965-66.

EXECUTIVE COMMITTEE

President

Dr. P. V. Cherian, *Governor of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.I.
Rev. Fr. H. Santapau, S.J.

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

Member

Secretary, Ministry of Education, Govt. of India

ex officio

Elected Members

Mr. Humayun Abdulali
Mr. G. V. Bedekar, I.C.S. (Retd.)
Prof. P. V. Bole
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. S. Majeedullah, I.P.S.
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday
Dr. T. Ramachandra Rao, D.SC., F.N.I.
Mr. D. E. Reuben, I.C.S. (Retd.)

ADVISORY COMMITTEE

Mr. H. G. Acharya	*Ahmedabad*
Mrs. Jamal Ara	*Ranchi*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. (Retd.)	*New Delhi*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Mr. M. Krishnan	*Madras*
Dr. N. K. Panikkar, M.A., D.SC., F.N.I.	*New Delhi*
Dr. Baini Prashad, D.SC., F.N.I.	*Dehra Dun*
Mr. P. D. Stracey, I.F.S.	*New Delhi*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*New Delhi*

4. The following recommendations made in the 1st and 2nd reports of the Sub-Committee appointed on the 7th May 1964 to study the Rules and Regulations of the Society and to prepare a list of the rules requiring amendment were considered :

1st Report, dated the 16th June 1964

Rule 5

For existing Rule 5, substitute :

' Life members are those members who have either on election or at some later date contributed to the funds of the Society in one sum a Contribution of Rs. 500 or such other sum as may be fixed by the Committee from time to time. Provided that, such members shall be entitled to adjust against the Contribution the annual subscription, if any, paid by them for the current year.

' In the case of an Ordinary Member who has paid the annual subscription for not less than 20 years, the Contribution for Life Membership shall be Rs. 150. Provided that, an Ordinary Member of twenty years' standing shall be entitled to adjust against the Contribution the annual subscription, if any, paid by him for the current year.'

Rule 6

In Rule 6,

(*a*) *for* 'co-operative' (*occurring twice*) *substitute* 'corporate'.
(*b*) *for* '22' *substitute* '25'.
(*c*) *for* '350' *substitute* '500'.

Rule 10

In Rule 10, *omit the second sentence.*

Rule 16

In Rule 16, *omit the words* 'residing abroad'.

Rule 22

Omit Rule 22.

Rule 27

In Rule 27, *for the words* 'and place' *substitute* 'at the Society's office'.

Rule 28

At the commencement of Rule 28, *insert the words :*

'Subject to the provisions of The Societies Registration Act of 1860 and Rule 18 above,'.

Rule 34

In Rule 34, *omit the last sentence.*

Rule 39

Omit Rule 39.

Rule 55

For existing rule 55, *substitute :*

'The Honorary Treasurer or his deputy shall demand and receive for the use of the Society all monies due or payable to the Society, and shall keep full and particular accounts of all sums so received. He shall also from time to time invest the funds of the Society as may be determined by the Committee. An account in the name of the Society shall be opened and all monies shall be deposited with such Bankers as may be appointed by the Committee. No payment shall be made by the Honorary Treasurer without the authorisation in writing of the Honorary Secretary or, in his absence, a member of the Committee. Subject to Budget provision and to such specific instructions as may be given by the Committee, the Honorary Secretary without reference to the Committee may pass for payment by the Honorary Treasurer all the bills in connection with the Journal, salaries, and other expenses of the Society.

'In case of emergency, the Honorary Secretary in consultation with the Honorary Treasurer may incur expenditure not exceeding Rs. 1,000, subject to the submission of a report to the Committee.'

Rules 60 & 61

For existing Rules 60 *and* 61, *substitute :*

'60. The Honorary Secretary shall conduct the correspondence, and shall be responsible for day to day administration of the Society's work.

'61. The Honorary Secretary shall have supervision over all employees of the Society and, subject to the control of the Committee, shall see that the Rules and Regulations and Bye-laws, and the orders of the Committee are executed.'

2nd Report, dated the 2nd July 1965

Rule 6

In the last line of Rule 6, *for* 'clause' *substitute* 'Rule'.

Rule 46

In Rule 46, *delete the last sentence,* 'All contracts.............. Honorary Secretary'.

Rule 62

In Rule 62, *for* 'and other the servants' *substitute* 'and other officers and servants'.

RESOLVED that the Rules be and are hereby amended as recommended by the Sub-Committee[1].

5. A Talk was delivered by Dr. H. Santapau, S.J., on the Indian Botanic Garden, illustrated by colour slides of the Garden.

6. The meeting terminated with a vote of thanks to Dr. H. Santapau, S.J., and to the Chairman of the meeting.

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[1] The Certificate of Registration and the Memorandum of Association of the Society, and the Rules and Regulations as they stand after these amendments are printed below at pp. 357-374.

No. 448

Certificate of Registration

I Hereby Certify That the BOMBAY NATURAL HISTORY SOCIETY is this day registered under the Societies Registration Act No. XXI of 1860.

Given under my hand at Bombay the Fourteenth day of March One Thousand Nine Hundred and Twenty Eight.

The Seal
of the Registrar
of Companies,
BOMBAY.

H. C. B. MITCHELL,
Registrar of Companies,
BOMBAY.

Bombay Natural History Society

(Registered under Act XXI of 1860)

MEMORANDUM OF ASSOCIATION

1. The name of the Society is the BOMBAY NATURAL HISTORY SOCIETY.

2. The objects of the Society are as follows :

(*a*) To promote the knowledge amongst the public of Natural History in all its branches, including particularly the study of Animal and Plant life of the Oriental Regions and the Zoo-Geographical Regions adjoining thereunto, both alive and otherwise.

(*b*) To carry out researches in all branches of Natural History and to assist with information and advice as well as financially where possible, other institutions and individuals in similar pursuits.

(*c*) To provide, purchase, construct, equip, maintain and replenish a museum or museums or other repositories for animals or plants living or dead which are suitable for the study of Natural History.

(*d*) To carry on the business of Taxidermists and preservers.

(*e*) To nominate and appoint members and to receive and recover contributions from them in aid of the objects of the Society.

(*f*) To engage and remunerate experts and other staff for any or all of the objects of the Society and to do and make all other acts, matters and things ancillary thereto or necessary and convenient for the purposes of the Society including the purchase or taking on lease of land and buildings.

(*g*) To borrow or raise money in such manner as the Society may think fit and in particular by the issue of debentures or debenture stock AND in security of any such money so borrowed or raised to mortgage pledge or charge the whole or any part of the property assets or revenue of the Society present or future by special assignment or otherwise or to transfer or convey the same absolutely or in trust and to give the lenders power of sale and other powers that may seem expedient and to purchase, redeem or pay off any such securities.

(*h*) To lend invest or otherwise employ monies belonging to or entrusted to the Society upon securities and shares or without security upon such terms as may be thought proper and from time to time to vary such investments in such manner as the Society may think fit and to deposit money with Bankers both upon current account or for a term.

(*i*) To do all or any of the aforesaid objects either solely or jointly with another or others and to enter into agreements for joint management, joint working, collaboration and any other arrangements with Societies or persons having similar or allied objects which may further or benefit the objects of this Society.

RULES AND REGULATIONS AS AMENDED UP TO 1965

THE MEMBERS

1. The Bombay Natural History Society (hereinafter referred to as 'the Society') shall consist of an unlimited number of Members of either sex whose election shall be vested in a Committee constituted as provided in Rule 32 (hereinafter referred to as 'the Committee'). Persons who were members of the Society prior to its registration shall so long as they shall observe and comply with the Rules of the Society be deemed to remain members of the Society, unless they shall otherwise determine, but any life or other subscription paid by them shall for the purpose of regulating their position or status in the Society be deemed to have been paid to the Society.

There shall be three classes of members—Life Members, Ordinary Members and Honorary Members.

2. Every candidate for admission as a member other than an Honorary Member shall be proposed and recommended in writing by one or more members of the Society.

Entrance Fee

3. The Entrance Fee both for Life Members and Ordinary Members shall be [1][Rs. 20/-] but the Committee may from time to time vary the same. No person shall be deemed to be a member until the entrance fee and subscription either as Life Member or Ordinary Member has been paid.

4. No dividend, gift, division or bonus shall be made by the Society unto or between any of its members in his or their capacity as member only, but any member occupying the position of a salaried official shall be entitled to receive remuneration from the Society for his services.

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[1] By Resolution No. 8 dated 4-7-1957 the Committee has varied the Entrance Fee to Rs. 5/-.

LIFE MEMBERS

5. Life Members are those members who have either on election or at some later date contributed to the funds of the Society in one sum a Contribution of Rs. 500/- or such other sum as may be fixed by the Committee from time to time. Provided that, such members shall be entitled to adjust against the Contribution the annual subscription, if any, paid by them for the current year.

In the case of an Ordinary Member who has paid the annual subscription for not less than 20 years, the Contribution for Life Membership shall be Rs. 150/-. Provided that, an Ordinary Member of twenty years' standing shall be entitled to adjust against the Contribution the annual subscription, if any, paid by him for the current year.

Corporate Bodies' Membership

6. Scientific Societies, Institutions, Libraries, Clubs, Officers' Messes and other such Corporate bodies shall be admissible as members in their Corporate capacity but shall not be admissible to Life Membership; such bodies may compound their annual subscription for a period of 25 years by payment to the funds of the Society of a sum of Rs. 500/- or such other sum as may be fixed under Rule 5 hereof.

7. The capital obtained from Life Membership contributions and compounded subscriptions shall not be used as revenue but shall be invested in Government Securities and the interest thereon only utilised as revenue. Provided always that if and whenever the market value of the investments shall equal or exceed the amount of the contributions and compounded subscriptions paid by the existing Life Members and the members who have compounded their subscriptions then and in such case it will not be obligatory to invest any further sums received by way of contributions from Life Members or compounded subscriptions but the same may be used as revenue.

It shall also be permissible for the Committee to decapitalize such investments and use the proceeds as revenue, provided that the market value of the capital remaining invested in Government Securities after such transaction shall not be less than the amount of the contributions and compounded subscriptions paid by the then existing Life Members and corporate members who have compounded their subscriptions.

ORDINARY MEMBERS

8. **Ordinary Members** are those persons who on election pay the entrance fee mentioned in Rule 3 hereof and the annual subscription.

9. If any person elected as a member shall omit to pay the entrance fee and annual subscription within 6 months from the date of his election, the Committee shall be at liberty to declare such election void.

10. The first annual subscription of members elected during the months of October, November and December in any year shall be considered to extend to the 31st of December of the following year.

11. The admission fee and annual subscription of members resident outside India, or of members absent from India shall be the same as for members resident in India.

12. The payment of the entrance fee by a member shall be considered as an acceptance by such member of all the Rules, Regulations and Bye-laws of the Society including the power to alter or vary the same.

Annual Subscription

13. The annual subscription of [1] [Rs. 25], or such other sum as may from time to time be fixed by the Committee, shall become due on the 1st of January in every year in advance. No member whose subscription is in arrear may exercise his privileges of membership; provided nevertheless that the

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[1] By Resolution No. 3 dated 9th June 1948 the Committee has fixed the annual subscription at Rs. 30/-.

Committee shall have authority to restore such defaulters on payment of all arrears.

14. When any member shall be in arrear in the payment of his annual subscription for two years he shall be advised by letter, addressed to his last known place of residence, that unless the amount due by him be paid within two months his name shall be removed from the list of members, and in the event of his failing to pay the amount within the period stipulated, his name shall be removed from the roll of members. The Committee may, however, restore the name of any person so removed upon such terms as they may think fit.

Members' addresses and changes thereof

15. Every member shall furnish in writing to the Honorary Secretary his address and any changes therein. The Society shall accept no responsibility for any loss or inconvenience that may arise through failure on the part of the member to carry out the provisions of this clause ; nor shall it be necessary for the Honorary Secretary to issue any notice to members failing to do so.

HONORARY MEMBERS

16. Honorary Members shall be eminent Zoologists or Botanists who have rendered distinguished service to the Society and shall not exceed 10 in number. Candidates for Honorary Membership shall be proposed by the Committee only and shall be elected by a majority of not less than three fourths of the Members of the Committee present, and any person so appointed shall be denominated an Honorary Life Member and shall have all the privileges of a Life Member under the Rules in that behalf.

WITHDRAWAL AND REMOVAL OF MEMBERS

17. Every member, having paid all fees due by him to the Society, shall be at liberty to resign therefrom upon giving notice in writing to the Secretary.

18. If any member shall have acted in a manner injurious to the good name of the Society or his membership shall have become undesirable so that it shall become expedient to remove his name from the list of members—the same shall be effected by a resolution of the Committee to be confirmed by a General Meeting of the Society. The proposition shall be ballotted for and if eleven or more members vote and not less than two thirds of the members so voting shall vote for such member's removal, he shall be removed from the Society accordingly.

PRIVILEGES OF MEMBERS

19. Members have a right to be present and vote at all General Meetings of the Society, to propose candidates for election to the Society and to have personal access for themselves or at their request their friends to such collections of the Society as are not open to the general public, to attend meetings of the members or functions of the Society and to introduce either in person or by signed orders visitors to any such meetings of the members or functions of the Society. Provided always that no friend or other person not being a member of the Society shall be entitled to be present at any General Meeting of the Society convened for the transaction of the business of the Society.

20. Any member by making application (in writing if required) to the Honorary Secretary may have liberty of access to the Society's Library. Members may borrow for a stated period from the Society's Library such books as are not required for constant reference, with the proviso that a member shall be liable to replace any loss or make good any damage to books while in his keeping.

21. One copy of the Society's Journal shall be sent free to every Honorary Member and Life Member and also to every Ordinary Member whose subscription is not in arrears.

22. [1] [* * *]

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[1] This rule was omitted by Resolution No. 4 passed at the Annual General Meeting on 30th July 1965.

23. Members shall have the right to purchase all publications of the Society at such price below the published price as may from time to time be fixed by the Committee.

ANNUAL GENERAL MEETING, ELECTION OF COMMITTEE, AND MANAGEMENT OF THE AFFAIRS OF THE SOCIETY

Annual General Meeting

24. A General Meeting of members of the Society shall be held annually in the month of March or as soon after as may be convenient, on a day to be fixed by the Committee. The Annual General Meeting shall be competent to receive and adopt the Annual Report and Audited Statement of Accounts of the Society for the past year and to transact any other business which may be brought forward by the Chairman.

25. Notice of the time and place of the Annual General Meeting shall be advertised in two of the local newspapers at least 14 days before the same shall take place.

26. The course of procedure at the Annual General Meeting after the chair has been taken shall be as follows:

(*a*) The reading of the Annual Report of the Committee.

(*b*) Presentation of the Balance Sheet and Statement of Accounts for the past year.

(*c*) The election of the Committee.

(*d*) Such other business as may be properly brought before the meeting.

Quorum : Adjourned Meeting

27. No business shall be transacted at any General Meeting of the Society unless a quorum be present when the meeting proceeds to business; 6 members personally present shall constitute a quorum. If within 15 minutes from the time appointed for holding a meeting a quorum be not present, the meeting shall be adjourned to the same day in the following week, at the same time at the Society's Office, and if at such adjourned meeting a quorum be not present within

15 minutes from the time appointed for holding the meeting, the members present whatever is the number shall be competent to transact the business for which the meeting was convened.

28. Subject to the provisions of The Societies Registration Act of 1860 and Rule 18 above, any question which may arise at any General Meeting of the Society or at any meeting of the Committee shall be determined by vote, each member having one vote and the President or Chairman a casting vote in addition to his own vote.

Extraordinary General Meeting

29. The Committee may, whenever they think fit, convene an Extraordinary General Meeting and they shall on the requisition of at least ten of the members forthwith proceed to convene an Extraordinary General Meeting of the Society.

30. Any request so made by members shall express the objects of the meeting proposed to be called and shall be left at the office of the Society. Provided that such requisition may consist of several documents in like form each signed by one or more requisitionists. Upon the receipt of any such requisition the Committee shall forthwith convene an Extraordinary General Meeting and if they neglect to do so within one month from the date of delivery of such requisition at the office of the Society the Requisitionists may themselves convene an Extraordinary General Meeting for the purpose specified and not for any other purpose, but no meeting so convened shall be held for three months from the date of the delivery of the requisition as aforesaid.

MANAGEMENT OF THE SOCIETY

Executive Committee and Advisers

31. The government and management of the Society shall be vested in a Committee consisting of (1) not more than six *ex officio* members, namely one President, not more than three Vice-Presidents, one Honorary Treasurer, and one Honorary Secretary, (2) ten ordinary members, resident in Bombay or within 200 miles of Bombay, and (3) the Secretary

to the Government of India in the Ministry dealing with Scientific Research or his nominee.

This Committee shall be assisted in an advisory capacity by ten members chosen by the Committee from amongst members resident in the mofussil more than 200 miles from Bombay. All papers in connection with meetings of the Committee shall as far as possible be sent in advance to the advisory members of the Committee.

Election of Committee

32. The Committee for the time being shall annually cause to be prepared a list of members whom they recommend to be elected as members of the Committee in the ensuing year. The names of the gentlemen so nominated shall be sent to all members along with the notice of the meeting and it shall be open to members, having obtained the previous consent of the nominee, to propose and second in writing within 7 days of the date of the meeting the names of any members they desire to have elected. In the event of the number of members proposed for the Committee exceeding ten, an election shall take place. The election shall be conducted as follows: A list of the names proposed shall be sent to every Life Member and Ordinary Member resident in India who has paid his subscription for the year and the member shall place his initial against the names of those he wishes elected and return the same duly signed by him in a special envelope marked 'Voting Paper' to the Honorary Secretary within three weeks of the issue of the same.

33. No voting papers shall be opened until 3 weeks after the date of the issue and they shall be opened by the Honorary Secretary in the presence of two members of the Committee and the result notified in writing to those elected and published in the next issue of the Society's Journal for the information of all members.

Vacancies

34. In the event of any vacancy on the Committee occurring during the course of the year the remaining members of the

Committee may fill up such vacancy whether it be of an ex officio member or ordinary member.

35. The first Committee of the Society formed under The Societies Registration Act, 21 of 1860, shall be the officers and Committee of the unregistered Society in office at the time of the registration of the Society whose names are set out in the list annexed to the Memorandum of Association.

THE DUTIES OF THE COMMITTEE

Committee Meetings

36. The Committee shall meet at such times as shall be appointed by the President or, in his absence, by one of the Vice-Presidents, Honorary Secretary or Honorary Treasurer, due and sufficient notice being previously sent to every member.

Quorum

37. At any meeting of the Committee 4 members shall form a quorum.

Notice of Meeting and Agenda

38. Seven days' previous notice of any meeting of the Committee shall, as a rule, be given in writing by the Honorary Secretary, to each member of the Committee and such notice shall specify the nature of the business to be transacted. Business of an urgent nature may be conducted by circular; and in such case, it shall be necessary in order to render valid any act of the Committee done upon a resolution by Circular, that the Circular shall have been seen by each member of the Committee present in Bombay, and that the majority of members shall have voted in favour of the resolution.

39. [1][* * *]

Decision by majority

40. The majority of votes shall decide every question brought before the Committee and in case of an equality of

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[1] This Rule was omitted by Resolution No. 4 passed at the Annual General Meeting on 30th July 1965.

votes the Chairman of the meeting shall have a casting vote in addition to his own.

Execution of contracts etc.

41. The President, Vice-Presidents or the Honorary Secretary upon the direction of the majority present at any meeting of the Committee at which not less than 6 members of the Committee are present shall be competent to sign on behalf of the Society any contracts, deeds, pleadings, and any other documents relating to the affairs of the Society and not inconsistent in their terms with the purposes or objects of the Society, or with the Rules and Regulations.

Gratuity, Provident Fund, etc.

42. A majority of the Committee present at any meeting at which not less than 6 members of the Committee are present may, at their discretion, and whenever they think fit, grant to an employee of the Society (whether employment be continued or not) in consideration of past services, or to the widow or any relation of a deceased employee either a pension or a bonus, gratuity or compassionate allowance of such amount as the Committee may fix, and upon such terms as they may prescribe, to be paid out of the funds of the Society and the Committee may also contribute out of the funds of the Society to a staff provident fund.

Sub-Committees

43. The Committee may appoint Sub-Committees for any purpose connected with the management of the affairs of the Society.

Bye-Laws

44. The Committee may from time to time frame Bye-laws for regulating the conduct and management of their business, or of the meetings or functions of any Sub-Committee appointed by them. But no such Bye-laws shall be inconsistent with any of the purposes or objects of the Society or with its Rules and Regulations.

45. The Committee shall be competent to invite any salaried official of the Society to be present at their deliberations.

Other powers of Committee

46. The Committee in addition to the powers and authorities by these presents or otherwise expressly conferred upon them may exercise all such powers and do all such acts and things including powers conferred upon the Society by clauses (*g*) and (*h*) of the Memorandum of Association of the Society as may be exercised or done by the Society and are not hereby or by law expressly directed or required to be exercised or done by the Society in General Meeting but subject nevertheless to the provisions of The Societies Registration Act of 1860 and of these presents and to any Regulations from time to time made by the Society in General Meeting provided that no Regulation so made shall invalidate any prior act of the Committee which would have been valid if such regulation had not been made.

PATRONS

47. One or more person or persons may be invited to accept the office of Patron of the Society at the discretion of the Committee.

48. Persons who have accepted the office of Patron of the Society prior to its registration shall be deemed to remain Patrons of the Society unless they shall otherwise determine.

VICE PATRONS

49. Any member of the Society who shall subscribe in his personal capacity a sum of not less than Rs. 5,000 to the funds of the Society to be devoted to fostering any of the objects and purposes of the Society shall, with the approval of the Committee, be appointed a Vice Patron of the Society.

50. A Vice Patron shall hold office until death or resignation.

51. Persons who were Vice Patrons of the Society prior to its registration shall be deemed to remain Vice Patrons unless they shall otherwise determine.

BENEFACTORS

52. Any member of the Society who shall in his personal capacity subscribe a sum not less than Rs. 1,000 to the funds of the Society to be devoted to fostering any of the objects or purposes of the Society shall be termed a ' Benefactor' and shall become a Life Member if not already so.

THE PRESIDENT AND VICE-PRESIDENTS

53. The President shall preside at meetings of the Society or of the Committee and regulate all the proceedings thereat and generally execute or see to the execution of the Rules and Regulations, Bye-laws and orders of the Society.

54. In the absence of the President from any meeting of the Society or of the Committee his place shall be filled by one of the Vice-Presidents, or by a member of the Committee then present, who shall for the time being have all the authority, privilege and powers of the President. If no member of the Committee be present at any Ordinary General Meeting, the members present shall nominate and appoint to be Chairman such member as they shall deem fit.

THE HONORARY TREASURER AND THE ACCOUNTS

55. The Honorary Treasurer or his deputy shall demand and receive for the use of the Society all monies due or payable to the Society, and shall keep full and particular accounts of all sums so received. He shall also from time to time invest the funds of the Society as may be determined by the Committee. An account in the name of the Society shall be opened and all monies shall be deposited with such Bankers

as may be appointed by the Committee. No payment shall be made by the Honorary Treasurer without the authorisation in writing of the Honorary Secretary or, in his absence, a member of the Committee. Subject to Budget provision and to such specific instructions as may be given by the Committee, the Honorary Secretary without reference to the Committee may pass for payment by the Honorary Treasurer all the bills in connection with the Journal, salaries, and other expenses of the Society.

In case of emergency, the Honorary Secretary in consultation with the Honorary Treasurer may incur expenditure not exceeding Rs. 1,000/-, subject to the submission of a report to the Committee.

56. An account shall be opened in the books of the Society for every member of the Society stating the several sums payable by him, and time of payment of the same. The particulars also of all sums of money received and disbursed in the several departments of the Society shall be entered and the books and vouchers shall be open to the inspection of every member.

57. The financial year of the Society shall end on the 31st December of each year and all accounts shall be made up to that date and shall be audited by one or more auditors appointed by the Committee.

58. The auditor shall have the power of calling for a statement of liabilities and assets of the Society and for any information relative thereto.

59. The Honorary Treasurer shall make a report to the Society upon the day of the Annual General Meeting and present a Balance Sheet and Statement of Accounts for the past year which shall be printed in the Journal of the Society.

THE HONORARY SECRETARY

60. The Honorary Secretary shall conduct the correspondence and shall be responsible for day to day administration of the Society's work.

61. The Honorary Secretary shall have supervision over all employees of the Society and, subject to the control of the Committee, shall see that the Rules and Regulations and Bye-laws, and the orders of the Committee are executed.

THE CURATOR, ASSISTANT CURATORS, ASSISTANTS, CLERKS AND SERVANTS OF THE SOCIETY

62. The Curator, Assistant Curators, Assistants, Clerks and other officers and servants of the Society with their respective salaries and duties shall be subject to orders of the Committee and they shall not under any pretence whatsoever receive any perquisite or profit from their connection with the Society, except that which shall be expressly allowed by the Committee.

63. Every servant of the Society receiving or paying money on behalf of the Society shall be required before he enters upon the duties of his office to give security for the due execution thereof in such penalty and with such surety or sureties as the Committee may deem expedient.

CERTIFICATE OF CORRECTNESS

We, being three of the members of the Committee in which the management and government of the Society is vested, do hereby certify that the above is a correct copy of the Rules and Regulations of the Society.

G. V. Bedekar,
Humayun Abdulali,
Zafar Futehally.

Dated the 30th of July 1965.

Notes and News

The Sálim Ali-Loke Ornithological Research Fund : An Announcement

We are happy to announce a donation of Rs. 10,000 by our Vice-President Dr. Sálim Ali. It is intended that this sum will form the nucleus of a research fund, the income of which will be used to promote the development of scientific ornithology and bird preservation in India by monetary assistance to and encouragement in other ways of biologists, both amateur and professional, in selecting whom preference will be given to young workers. The fund will be known as The Sâlim Ali-Loke Ornithological Research Fund to commemorate Dr. Sálim Ali's long association with the Society and his life-long interest in birds, as well as his abiding friendship with the late Dato Wan Tho Loke from whose interest in birds, developed during his war-time association with Dr. Sálim Ali, both the Society and Indian ornithology have benefited. An appeal for further contributions to the fund will be issued separately.

Another Announcement, and an Appeal

We are happy to announce another generous donation by Dr. Sálim Ali, a gift of his valuable collection of natural history books and journals consisting of about 500 volumes and 1000 separates of scientific papers.

We would commend this example to our readers and ask them to consider the desirability of preserving books of value for the use of scientific workers, particularly books which are now out of print and not available for purchase and which might otherwise perish or be lost by passing to heirs who are not interested in them and do not realise how precious they are.

Your Help is Needed : Bird Migration Study by the Smithsonian Institution, Washington, D.C.

Hundreds of thousands of ocean birds are being captured, marked, and released on mid-Pacific islands in a widespread study of sea-bird migration by the Smithsonian Institution, Washington, D.C. Although it is known that some kinds of birds perform annual migrations of 10,000 miles or more over the North and South Pacific Oceans, the regular beats of most species are unknown or poorly understood.

To learn more about the migrations of sea-birds, Smithsonian ornithologists have captured and marked over 3,00,000 birds of 28 different kinds in the Central Pacific with standard, numbered, United States Fish and Wildlife Service aluminium leg-bands. Of these, over 60,000 have been marked with 4-inch coloured plastic leg-streamers.

Anyone coming into possession of a banded dead bird in the Pacific Ocean Area is asked to co-operate by returning the band, together with time and place of recovery as instructed on the band. For live birds, only the band number together with time and place of capture need be sent *to the address given on the band*; the bird should be liberated so that its further travel may be traced. Please note that the Smithsonian Institution does not want reports about birds banded by other organizations.

Anyone sighting a bird with a coloured leg-streamer anywhere in the Pacific Ocean Area is asked to co-operate by recording the name or description of the kind of bird wearing the streamer, the colour of the streamer, the date seen, and the latitude and longitude or approximate location of sighting. All information on birds with coloured leg-streamers should be sent as soon as possible to: Division of Birds, Smithsonian Institution, Washington, D. C. 20560.

Each co-operator will be advised where the banded or colour-marked bird was tagged. Please help.

Symposium on 'Recent advances in the development, production and utilisation of medicinal and aromatic plants in India'

A symposium on 'Recent advances in the development, production and utilisation of medicinal and aromatic plants in India' under the auspices of Central Indian Medicinal Plants Organisation will be held at Lucknow on 12, 13, and 14 January 1966.

The symposium will be confined to developments in the production and utilisation of medicinal and aromatic plants in India since 1955.

For contribution of papers and other information, letters should be addressed to Dr. S. C. Datta, Central Indian Medicinal Plants Organisation, 4 Sapru Marg, Lucknow.

Palynological Society of India

The Palynological Society of India, founded on 5 January 1965, has undertaken the publication of the *Palynological Bulletin* (Annual), to be issued in July-August, and the *Journal of Palynology* (Annual), to be issued in December.

Membership of the society is open to all persons interested in the study of pollen and spores, in India and outside. Members, depending on the category, are entitled to free copies of one or both of these publications.

Further particulars and membership forms may be obtained from Dr. P.K.K. Nair, General Secretary-Treasurer, Palynological Society of India, National Botanic Gardens, Lucknow.

An Appeal to our Lay Readers

Eighty years ago, in the very first issue of the *Journal*, the Editors wrote: 'In accordance with the character which this Society has assumed from the beginning, the aim of its journal will be, as far as possible, to interest all students of Nature, ever remembering that there are many Naturalists, in the highest sense of the term, who have not such a technical knowledge of any particular branch of the science as to be able to enter with interest into questions of nomenclature and the discrimination of closely allied species. The Secretaries of the Sections [Mammals and Birds, Reptiles and Fishes, &c.] would, therefore invite sportsmen and others to communicate anything interesting or worthy of note, which comes under their observation, bearing on the nature and habits of animals or plants.'

Our object remains the same and we repeat the invitation. The flora and fauna of the Indian Region are so varied, and so little observation has been done in the field, that every intelligent person, independent of the extent of his technical knowledge, can help by noting immediately and reporting on facts of Nature that interest him and by asking questions about anything that puzzles him—we shall do what we can to deal with his questions. All the relevant particulars should be recorded, e.g. time, place, special features of the locality, details by which the plant or animal concerned can be identified. Specimens should be obtained and sent, where this does not involve serious destruction. Do not be put off by the thought that these facts may be known already. Even if this is so, we may be able to put you on to other relevant facts of an interesting nature ; and there is always the possibility that you have come across something that is not generally known. In a stray case, you may have discovered something that is new to the scientists, and will be instrumental in directing their inquiries in a new direction.

Gleanings

Cape Hunting Dogs (*Lycaon pictus*) in East Africa

In *Nature*, 30 January 1965, Dr. Wolfdietrich Kühme gives an interesting report of the result of his observations of a pack of Cape Hunting Dogs (*Lycaon pictus*) in the Serengeti plains extending over about four months. Among other things, he reports that hunting was confined to two definite periods, in the morning and the evening, which remained unchanged from day to day, and there was no hunting at night. Between these two periods game was seen to approach without being molested. The guarding of the puppies during the hunt was allotted to the females and particular males. The meat of slain animals was immediately swallowed by the hunters and was then transported in their stomachs to be disgorged and shared with the puppies and their guards.

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THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 2nd (revised) edition. 28 plates in colour by Paul Barruel and many other illustrations. **Rs. 30**

(*Price to members* **Rs.** 25)

Birds

The Book of Indian Birds, by Sálim Ali. 7th (revised) edition. 64 coloured and many monochrome plates. **Rs. 25**

(*Price to members* Rs. 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**

(*Price to members* Rs. 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**

(*Price to members* **Rs.** 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn **Rs. 20**

(*Price to members* Rs. 16)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**

(*Price to members* Rs. 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**

(*Price to members* Rs. 4.50)

Glimpses of Nature Series Booklets :

1. OUR BIRDS I (with 8 coloured plates) in Gujarati, Hindi, and Marathi. **Rs. 0.80**
   Kannada **Rs. 0.62**
2. OUR BIRDS II (with 8 coloured plates) in Hindi. **Rs. 0.62**
3. OUR BEAUTIFUL TREES (with 8 coloured plates) in Gujarati, Hindi, and Marathi. **Rs. 0.62**
4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
5. OUR ANIMALS (with 8 coloured plates) in English, Gujarati, Hindi, Marathi. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Correspond with :

The Honorary Secretary,
Bombay Natural History Society,
Hornbill House, opp. Lion Gate, Apollo Street, Fort, Bombay 1-BR.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Near Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the *Journal,* particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.
Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50) if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

Journal of the Bombay Natural History Society

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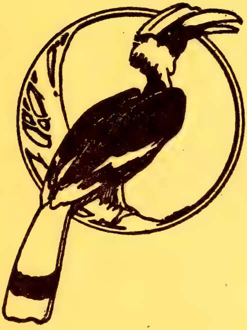
Vol. 62, No. 3

Editors
H. SANTAPAU, S.J., D. E. REUBEN,
ZAFAR FUTEHALLY, & J. C. DANIEL



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NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions :

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

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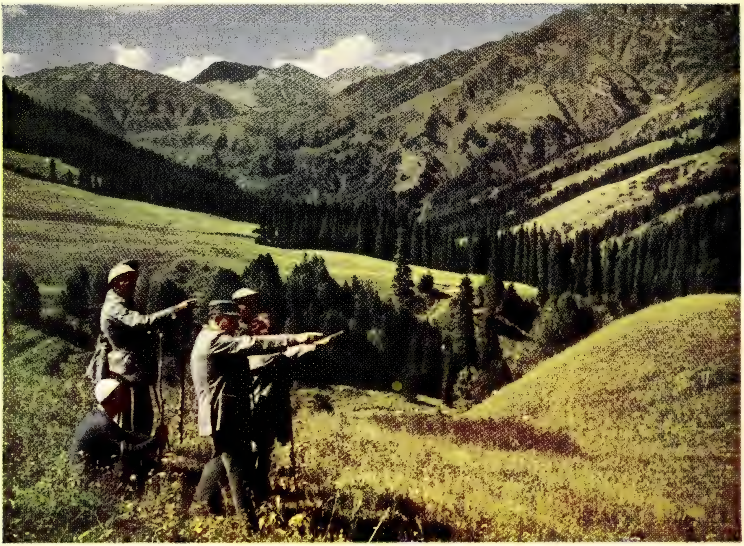
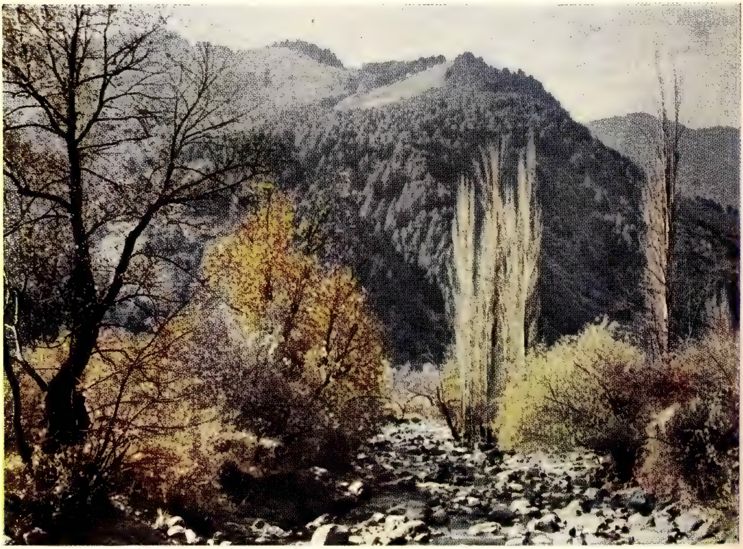


The author with game watchers in Upper Dachigam in September, *c.* 11,000 ft.



Lower Dachigam in November, showing the River Dagwan

(*Photos : E. P. Gee*)

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Report on the Status of the Kashmir Stag: October 1965

BY

E. P. GEE, M.A., C.M.Z.S.

(*With one coloured and four monochrome plates*)

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I. INTRODUCTION

This report deals with the Kashmir Stag, *Cervus elaphus hanglu* Wagner, 1884—known locally in Kashmir as the *hangul* and to some sportsmen as the *barasingha*. Although the *hangul* is a subspecies (of the Red Deer *Cervus elaphus* of Europe), it assumes some significance as being probably the only Asiatic survivor of this genus, since *Cervus elaphus wallichi* (the *shou*) appears to have disappeared from the Eastern

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Himalayas, and the present status of the other Asiatic subspecies is unknown and rather doubtful.

It is not possible for me to provide a great amount of useful information on the *hangul*, for my knowledge of it is only based on a few very brief expeditions to its habitat during the past eight years and a perusal of the available literature on the subject. Rather I am attempting in this report to depict some of the background which may be useful to ecologists in the future ; and I am drawing attention to what is *not* known rather than to what *is* known. I also refer to the necessary measures which are not (so far as I am aware) being taken to ensure its survival.

II. General Review and Summary of Report

The *hangul* of Kashmir are definitely declining in numbers, and at the present downward rate are certain to become extinct in the foreseeable future—unless effective steps are taken to preserve them. Considering that their main habitat is not only the main catchment area of the Srinagar water supply but also a most beautiful part of the world, it seems obvious that full protection should immediately be given to both the *hangul* and its habitat by the creation of a sanctuary or national park.

III. Historical

Up till 1947 Kashmir was a princely state, and the *hangul* were regarded as ' royal game ' by the Maharaja. As such they were strictly protected in various game preserves or *rakhs* so that their numbers would be sufficient to provide sport for the Maharaja and his friends.

Although there is a lot of data on where the deer were to be found, on how to stalk them and on the measurements of the animals and their antlers after they had been shot, very little has been recorded of their life history, habits, social behaviour and so on.

And although there were game wardens and staff for the protection of game, nothing is mentioned of the numbers of *hangul* in the old days. No estimates have even been given, but after discussing this subject on many occasions with experienced Kashmiris I am led to believe that there may have been about 3000 to 5000 of them some sixty years ago, and about 1000 to 2000 in the year 1947.

During the troublesome years that followed the constitutional accession of Kashmir to India and the objections of Pakistan to Kashmir being administered by India, their numbers may have become depleted to about 300, but by 1957 they seem to have increased a little, to (say) 400. In 1957-58 a rough estimate was made by the local staff which put their numbers at 550—a figure which I think may have been on the optimistic side.

By the end of 1960 enquiries revealed that they may have fallen to about 250, and some people thought in 1962 that there may be only 175-200 still in existence, although an official ' census ' in that year put the population at 360. In February 1965 the local staff did another ' census ' and gave their numbers as 280, but I always prefer to be more conservative in such matters and think there may be only about 180 left alive today.

Fortunately not much of the habitat of the *hangul* is on or near the cease-fire line between India and Pakistan, and most of the *rakhs* fall in that part of Kashmir administered by India. The real danger, then, to the survival of the *hangul* has been and still is the generally unsettled conditions and not directly the military operations. It appears that absence of real stability in the region has prevented genuine and lasting conservation measures from being instituted. Priority is usually given to the more immediate and pressing day-to-day needs of the people, to the detriment of long-term measures designed to conserve nature and wild life for the ultimate benefit of the country.

IV. Geographical and Ecological

The part of the valley of the Jhelum which constitutes the broad and beautiful Vale of Kashmir is approximately 5000 ft. above sea-level, with the surrounding mountains rising up to 13,000 ft. and more. Numerous tributaries flow into the Jhelum, and it is in some of these smaller and narrower valleys that the deer come down to winter at elevations of about 5500 ft. to 6000 ft.

The climate and vegetation of the valleys could be loosely described as temperate 5000 ft. to 8000 ft., then sub-alpine 8000 ft. to 9000 ft. and then alpine 9000 ft. to 14,000 ft. The summer range of the *hangul* is spread over the mountains as high as 15,000 ft. or 16,000 ft., while in the winter they come down to the valleys as mentioned above. By far the larger number come down to Lower Dachigam (13 miles from Srinagar) and neighbouring *rakhs*. These lower valleys include willow and oak (the latter introduced from Britain) on which the deer browse in the winter, while the upper ranges include blue pine, juniper and birch. A beautiful stream named the Dagwan, stocked with brown trout introduced from Britain about sixty years ago, flows through Lower Dachigam.

In the centre of Lower Dachigam is the former shooting lodge of the Maharaja, called Draphama Rest House, about 16 miles from Srinagar. Three miles further up the valley is Phalipora Rest House. There are several ' fire lines ', relics of old shooting days, which are still cleared every year at the end of March to provide unobstructed views of the deer to staff and visitors.

The only other deer existing in the area besides the *hangul* is the tiny musk deer *Moschus moschiferus* which somehow survives near the snow line in spite of being persecuted for its musk pod. Wild predators on the *hangul* are the leopard *Panthera pardus*, the marten *Martes foina intermedia*, the black bear *Selenarctos thibetanus* and the brown bear *Ursus arctos.*

With regard to predators Ward (1921) records : ' Leopards take many deer, both stags and hinds. Bears are always on the look-out for new-born fawns. The Indian martens when hunting in families will pull down fawns of six or eight months of age ' ; and Stockley (1936) writes : ' Leopards are a terror . . . Kashmiris say that a leopard will spring on a calf and lie on it without killing it, until its bleatings draw the mother near enough for the leopard to seize her, and the calf is also then killed. Two reliable observers have told me of coming on a scene which would bear out this Kashmiri story, and in each case the interruption sent off the leopard and the calf was quite unhurt, although the leopard had been lying on it. '

As for black bears Stockley (1936) has recorded : ' Black bears are destroyers of new-born calves, and will work along a hill-side trying the upward wind for the scent of hind and young '. Col. Harry Nedou has informed me that he has seen a brown bear kill twenty sheep of which it probably took away one to eat, but he does not think that bears kill deer.

But by far the worst predators of the *hangul* are human beings. These vary from V.I.Ps., who somehow obtain a permit from the Prime (now Chief) Minister of Kashmir to shoot a stag (supposed to be a protected species) even inside Dachigam (supposed to be a sanctuary), down to local villagers with their crop-protection guns. And high up in the mountains during summer the professional graziers, shepherds and goatherds (*gujars*, *bakr-wallas*) with their flocks of domestic animals have guns and dogs with which they seem to kill the deer whenever possible.

About these graziers Ward (1925) says : ' The disturbance caused by the goatherds and the shepherds acts in a deleterious way on the best stags, as they keep up high, seldom consorting with the herds.' And Stockley (1936) states : ' They are too much poached by the *gujars* ', and : ' By far the worst enemies of the *barasingh* are the *gujars* and the shepherds . . . . Most damage is done amongst the hinds, and many are shot in summer by the shepherds high above the tree line '. And Col. Harry Nedou has again and again informed me of the havoc wrought by poachers with their crop-protection guns and by the *gujars* and *bakr-wallas* with their guns and dogs.

V. ADMINISTRATIVE AND POLITICAL

The preservation of wild life in Kashmir is the responsibility of the Game Warden, who is (nowadays, at any rate) an officer of the Forest

Department and therefore under the Chief Conservator of Forests. Due, however, to the peculiar status of Lower Dachigam, which possesses (1) a trout hatchery with channels drawn off from the river Dagwan, (2) a certain amount of forest as well as the *hangul*, and (3) a beautiful rest house amid wonderful scenery where the deer come in the winter, the place has successively been under the administration of (1) the Fisheries Department up till 1954, (2) the Forest Department 1954 to 1960, and (3) the Tawaza (or Entertainment) Department 1960 to 1964, and (4) again back to the Forest Department 1964 onwards.

So it is not difficult to understand why there has been some confusion and lack of continuity in the administration of Lower and Upper Dachigam which constitute the main habitat of the *hangul*. Paradoxically enough, the deer probably received the best protection of all while under the Fisheries Department, because the Head of that Department, G. M. Malik, was not only an able officer but also himself interested in the survival of Kashmir's wild life.

But it is obvious that as the Game Warden, whose duty it is to preserve the wild life of the State, is under the Chief Conservator of Forests, and as there are considerable patches of forest in the area, the place ought to be under the Forest Department—which should have sole and full control and therefore full responsibility for the preservation of the flora and fauna of the area.

The status of the 52 square mile Lower and Upper Dachigam was originally a *rakh* or game preserve of the Maharaja. I understand that it was notified as a sanctuary in Order No. 276/c of 1951 dated 14-3-1951 while under the jurisdiction of the Fisheries Department, but the other Departments (i.e. Tawaza and Forest) do not appear to be aware of this, and its status continues to be uncertain. (The Forest Department is now maintaining a staff of 2 Rangers, 2 Deputy Foresters or Head Watchers and 18 Game Watchers in the whole of Dachigam.)

The position of Dachigam is further complicated by the fact that other Departments also have a claim on the area. For it is the catchment area of the Srinagar water supply, with the Harwan reservoir just outside the southern boundary, and the Irrigation and Water Works Departments have a big say whenever discussions are held. In addition, the Public Works Department is in charge of the road through Lower Dachigam ; and the Electricity people go there to maintain the small generator and overhead wires, with the Telephone people going there to repair their wires. Also I hear that the Mulberry people are trying to go there, and also graziers of domestic cattle !

Of course most of the above separate Departments have their role to play and their own specialized work to do, but unfortunately there does not appear to be much, if any, co-ordination between them, and they all seem to act independently of each other.

Clearly it would be advantageous from every point of view if only one Department, preferably the Forest Department, were to be in overall charge of the whole place, and if all the other Departments were to be subordinated.

Finally the character of the whole place has been changed by yet another Department entering on to the scene. The Department of Agriculture has recently entered the fray in a big way with a Government Sheep Breeding and Research Farm. For this purpose about four square miles of Lower Dachigam have been occupied, and Rs. 10,00,000 worth of buildings constructed. In addition to more than 1000 sheep, there are a number of dogs (officially 4 but really about 40, so I was told), goats (officially 15 but really about 40-50) and a staff of about 25 men with extra men engaged in grass/hay collecting.

These sheep, together with the goats which are kept as ' leaders ' of the sheep, are stall-fed during the winter and therefore do not compete very much with the deer for food in Lower Dachigam. But in the spring when the snow melts the sheep come out and enter into direct competition with the deer for the grazing in Upper Dachigam until the late autumn. The effects of combining sheep and deer in the same range are not beneficial to either, and these will be discussed later.

In the meantime it is sufficient to say that it appears to be a most unfortunate planning mistake that the Sheep Farm, which could have been sited in other parts of Kashmir where there is good and even better grazing, should have been allowed to be set up in the catchment area of the Srinagar water supply which is also the home of the rare Kashmir Stag and the main potential national park of Kashmir.

VI. General Account of my Visits

My first visit to Lower Dachigam took place early in April 1957, when patches of snow were still on the ground and the spring flowers were starting to appear. Nearly all the stags had already migrated to higher elevations, but I saw quite a fair number of hinds and fawns. They were not very shy, and I was able to photograph and film them without much difficulty during a number of days.

I visited Upper Dachigam in September of the same year, camping at Sangergulu at about 11,000 ft. I saw several *hangul* but they were scattered in small groups and too far away to be photographed. Although the summer flowers in the alpine meadows were nearly over, the mountain scenery was simply magnificent, defying any attempt at description.

I went to Lower Dachigam again in all its autumnal glory in early November 1960, and in the thickets glimpsed a fine 10-pointer stag with a group of hinds and fawns. But the majority of the deer had not yet come down.

In August 1964 I paid a visit to Lower Dachigam, and was surprised to learn that about ten hinds (but no stags) had remained behind in their winter range and had not migrated to higher elevations. I also learnt, after much questioning (with the Game Warden acting as interpreter), that this phenomenon occurs every year. Some investigation, I think, needs to be done to ascertain whether these hinds are barren ones, or some of those which in alternate years do not breed, or very young or very old non-breeding animals, or animals enfeebled to some extent by injury or ill-health.

Finally, I spent nine days in Lower Dachigam in February 1965 when it was still winter, in order to observe the *hangul* more closely and obtain photographs of them in the snow. I found them much fewer than in 1957, and much more frightened of human beings.

Accompanied by Qasem Wani, the second Game Watcher, I set up my cloth hide on 24-2-1965 and disguised it with branches and leaves, near a salt-lick, and waited each afternoon. On the previous day we had seen a 12-pointer stag, a 10-pointer, a 2-pointer and nine hinds at this place when I arrived on the road ; and later that afternoon when I was searching for the best place for erecting the hide three hinds came very close, the leader uttering her staccato barks of apprehension. On 24-2-1965 when I sat up in the hide an 8-pointer, two 2-pointers and about 30 hinds and fawns came to the lick and were photographed in the fading light ; but they had become noticeably more wary than on the first day. For the next two days none came. On 27-2-1965 about 30 hinds and fawns came out. Then for the next three days only wild pig came, no *hangul* : apparently they had become even more wary.

The reasons for this increased wariness were probably as follows : Firstly, there was continual disturbance from some men of the P.W.D. working on the road near by, the men employed by the Sheep Breeding Farm, the men of the trout hatchery, the men of the rest house and others.

And secondly, a thaw had set in, and it appears that *hangul*, like the Red Deer of Europe, may become more irritable and wary during a thaw because of changes in humidity. Darling (1937) has observed that Red Deer in Scotland are calmer and more approachable in dry atmosphere with low humidity, or at saturation point : ‘ if humidity remains steady there is olfactory accommodation and irritability is lessened ’. With steady frost and steady humidity and still air there is less scent and the deer are more approachable. But with variable humidity the deer become more irritable, and snow in its onset and disappearance causes the most spectacular movements of deer.

While I was waiting in my hide for chances of photographing *hangul*, a friend of mine accompanied Ghulam Hyder, the Head Game Watcher, to observe the numbers and other details of deer seen on the mountain slopes. A group of stags comprising a 12-pointer, a 10-pointer, an 8-

pointer and a 2-pointer was seen on several occasions. Small groups of hinds and fawns up to 18 in number were moving here and there. But there seemed to be no definite pattern in the groups, for sometimes a stag or two accompanied the hinds and fawns.

The total number estimated to be in Lower Dachigam was said by Ujaggar Singh (the Range Officer), Ghulam Hyder and Qasem Wani to be in the region of 160.

The details given to me by S. Atta Mohmad Khan, the Game Warden of Kashmir, of the annual ' census ' (really an estimate, I think, and to be read with some degree of conservatism and caution !) conducted early in 1965 are as follows :

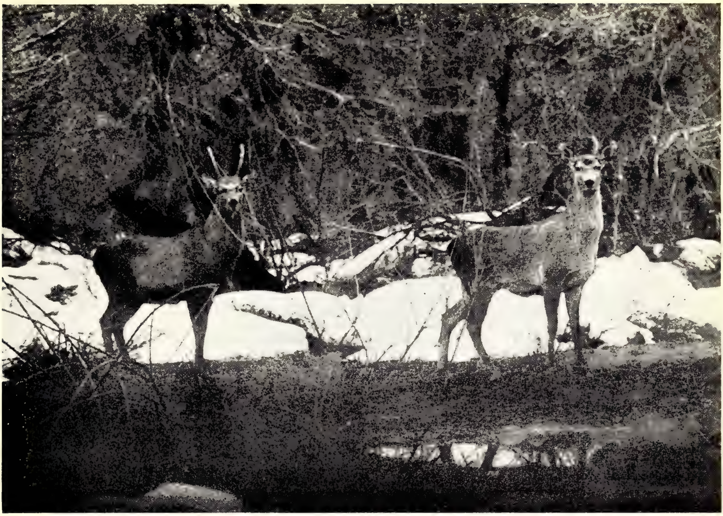
LOCALITY	STAGS	HINDS	FAWNS	TOTAL
Lower Dachigam ..	10	110	40	160
Tral Range ..	28	69	*	97
Srinagar Range ..	5	8	*	13
Dessu Rakh ..	2	8	*	10
			Grand Total	280

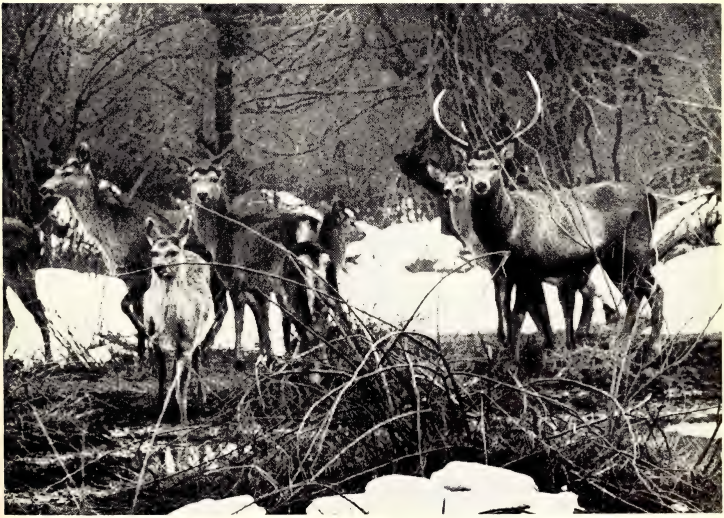
* In these cases the number of fawns is not given, and must be considered as merged with adults.

In the above figures the alarming factor is the imbalance of the sex ratio, especially in Lower Dachigam, where it is 10 stags to 110 hinds, or 1 stag to 11 hinds. Stockley (1936) mentions that in his time the ratio was 3 stags to 10 hinds. G. K. Whitehead has informed me that he considers the ideal ratio for Red Deer to be 1 stag to 1½ hinds. Darling (1937) states that 1 stag to 2 hinds is the optimum ratio, and says that the mature stags come first into rut, and that their fawns being born earlier are the most likely to survive the following winter.

With so few stags in Dachigam, it means that they might suffer from exhaustion during the rut, having to cope with a larger number of hinds—especially if a spell of cold weather follows the rut. And with so few mature stags available, and with disturbance from shepherds and others up in the mountains, there will be less chance of the adult stags mating with the hinds. Also younger stags will have more opportunity, and as Darling (1937) points out the younger and immature stags come into rut later, and their progeny being born later are less likely to survive the winter. He says : ' late calves would be better unborn, for the winter takes extra toll of them . . . . a population diminishing by such means is in serious danger of extinction '.

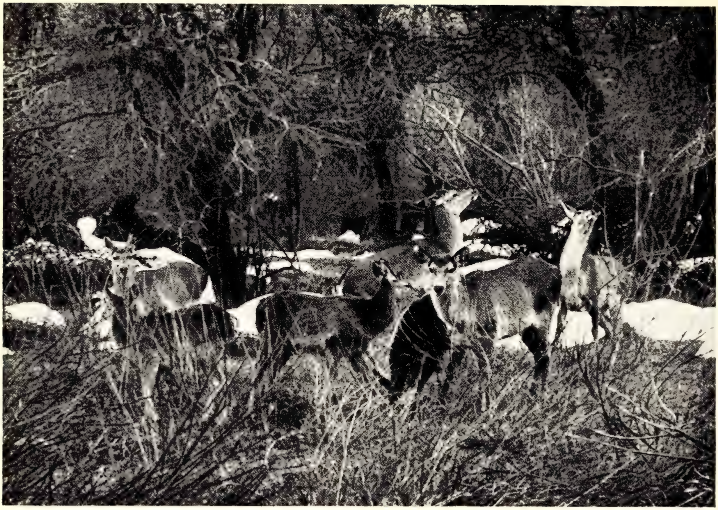
Incidentally, *hangul* stags shed their antlers from the middle of March to the end of April. The new antlers are hard and clean by the middle of September when the rutting season commences. The height of the rut is said to be about October 20th. The fawns are born in April and May, and hinds usually produce in alternate years.





Above : A *tuj* and a hind in February. *Below :* Hinds, fawns, and an 8-pointer stag near the salt-lick

(*Photos : E. P. Gee*)



Above : A couple of hinds have a difference of opinion. *Below :* The 'hide' from which the three foregoing photographs were taken, after the thaw

(*Photos : E. P. Gee*)

On my last day in Dachigam I visited the Sheep Farm in company with Rashid Wani, Soil Conservation Officer ; and I am grateful to the Manager of the farm for showing us round. Some details of the farm have been given earlier in this report, and the probable effects of sheep in a deer range are stated in the next section.

VII. PRESENT STATUS AND FUTURE OF THE KASHMIR STAG

The present status of the *hangul* is precarious. Although there have been no real censuses conducted by competent persons on a scientific basis, the rough estimates given in section III are a pointer to the direction in which the *hangul* is heading :

YEAR	NO. OF *hangul* IN KASHMIR
1900	3000-5000 ?
1947	1000-2000 ?
1954	300 ?
1957	400 ?
1958	550*
1960	250*
1962	360*
	200 ?
1965	280*
	180 ?

KEY. ? indicates my own estimate ;
* indicates official 'census' figure

In addition to the above figures, which are for Kashmir, there are reported to be a few, perhaps only half a dozen, *hangul* in the Chamba District of Himachal Pradesh. These are said to be under strict protection.

Although the main habitat of the deer, Lower and Upper Dachigam, was supposed to have been made into a sanctuary in 1951, nothing appears to have been done to implement the Order. And although the Kashmir Stag was placed by the Indian Board for Wild Life on the list of species for full protection as long ago as 1952, nothing appears to have been done to give legal protection to the animal.

Even if wild life preservation cannot receive a high priority from the Kashmir Government, yet still the fact that Dachigam is the catchment area for the Srinagar water supply is sufficient reason for the full protection of the whole valley. So far from giving full protection to this catchment area (which also happens to be the home of the rare *hangul* and a potential national park), some grazing by domestic cattle and some firewood collecting have been allowed there, and vast flocks of sheep have been housed there.

Regarding cattle, Stockley (1936) has remarked : 'Foot and mouth disease has also taken terrible toll of the deer in the last ten years, and the cause of this must be put down to errors of preservation. Every winter large numbers of deer crowd into the safety of the State *rakhs*, of which the principal, and far the largest, is Dachigam . . . . which is much fouled by village cattle . . . . These deer contract the fatal disease and carry it up with them to the high grounds when the snows melt, infecting others and spreading the disease over a wide area.'

Very recently some new information has come in concerning the danger of allowing domestic cattle to graze in wild life sanctuaries in India. During 1964 Schaller (Shah et al. 1965) took sera of deer in Kanha National Park, where a great number of cattle are somehow allowed to graze inside the park. Examination of these sera with those taken from deer in the United States of America shows that ' . . . the antibody prevalence in Indian deer (6 of 10) was higher than in the U.S. deer (1 of 39). A reason for this finding may be that in Kanha Park, the deer are more likely to be in contact with cattle which graze in the same forests and compete for forage.' In a covering letter to me Dr G. B. Schaller has pointed out that this virus (*Myxovirus parainfluenza 3*) ' is the main agent causing shipping fever in cattle. It does not affect the deer until they are put into a stressful situation—like food shortage. Then it may kill them. The virus is undoubtedly gotten from the cattle. Another reason for keeping cattle out of a sanctuary ! '

Regarding the sheep, it is a fact that these are stall-fed in the winter, and therefore there is perhaps no severe strain on the grazing/browsing potential of Lower Dachigam in the actual winter. And at the rate of one deer to 65 acres (ten per square mile) and one sheep to 25 acres, there should be sufficient summer pasture in the mountains for both the deer and the sheep (if the latter are restricted to 1000). But there are other factors to be taken into account :

1. DISTURBANCE from men, guns, dogs, goats and so on. In addition to the sheep actually grazing, some 25 men are in charge of the sheep, and with firewood collecting, hay and grass collecting and so on, the amount of disturbance must be very great all the year round. The men possess some guns—ostensibly for self-defence and sheep-defence against leopards and bears—and who is to know whether these guns will not be used for shooting deer ' for the pot ' or for sale ?

Darling (1937) says of a certain part of the Scottish highlands : ' The presence of sheep is the reason for the few deer on these last-named areas. Deer and sheep have similar tastes in grazing, and while the carrying-capacity of a forest is lowered by even a light sheep stock, say one to ten acres, there is disturbance by men and dogs which is, I think, of greater importance '.

The existence of similar tastes in grazing is confirmed by Murie (1951) who says : ' Sheep are as " omnivorous " in their selection of plant foods as elk and they get over all kinds of terrain. Here we must recognize direct competition, from every standpoint.' And Smith (1953) says :

'Rubbing trees' in Lower Dachigam, where the stags thrash their antlers
(*Photos : J. N. Newton*)

Hinds in the undergrowth of Lower Dachigam in April, after a thaw
(*Photo : E. P. Gee*)

The Dagwan River, above the Draphama rest house, in Lower Dachigam, in April

(*Photo : E. P. Gee*)

'The similarity of deer and sheep diets is sure to cause conflict wherever the supply of preferred species is inadequate to satisfy the requirements of both animals'.

2. PARASITES AND DISEASES. There is always great danger that the parasites and diseases of the sheep may spread to the deer. Longhurst (1954) says of blacktailed deer in California that they shared with sheep 21 species of parasites. And that this affected the deer adversely because both competed for the same forage and in the winter the sheep received supplementary food from man, which the deer did not. As the result of lack of food and parasitism many deer died during the winter while the sheep survived.

And Whitehead (1950) says of sheep that they 'have so many of the same parasites and diseases that attack deer, and they may even introduce other ailments to which deer are not normally exposed'.

My own considered opinion is that unless Lower and Upper Dachigam can be constituted into a sanctuary or national park to be entirely under the jurisdiction of one Department (the Forest Department) to the exclusion of all other interests except water supply and trout hatchery, and unless all grazing by domestic cattle and firewood collecting can be eliminated, and unless the sheep can be removed, and unless the *hangul* can be given full protection—unless all these measures can be effectively taken, not only will the *hangul* become extinct but also the catchment area of the Srinagar water supply will ultimately become denuded, eroded and ruined.

It has been officially stated by the Kashmir Government that they are shy of making Dachigam into a sanctuary or national park because the entry of visitors would contaminate the water supply. I myself cannot understand this argument. For a few visitors entering by car, on payment of a fee, and stopping at the Draphama Rest House, would not contaminate the area, as must do the labourers working on the road, the men of the sheep farm and so many others ! And when massive firewood cutting was once done by 200 labourers, was there then no outcry against contamination ?

The steps listed above need to be taken in order to save the area and the wild life from destruction. In addition, I recommend, and have been for the last eight years recommending, that a small number of *hangul* be kept in an enclosure somewhere between Dachigam and Srinagar for the purpose of ensuring the survival of the deer and also for providing a tourist attraction. This would not be a difficult or expensive step, and it has been done before in the time of the Maharaja.

Of capturing these deer and keeping them in captivity, Ward (1921) says :

'In order to capture full grown stags and hinds it is essentially necessary to choose suitable ground. A well-wooded southern slope under a ridge of hills with a pronounced low dip in the range is an ideal place. On the southern slopes of the mountains few trees grow, they are covered with grass.

'The herd of deer having been located in the northern woods are slowly driven upwards by a few well-trained men during the day time when the breeze blows upwards, in other words the deer are " given the wind ". If not hustled too much they will work their way to the lower part of the range. When close to the top, the beaters fire a gun or shout, the herd breaks into a gallop, and dashes wildly down the southern side. There in the grass are set long lines of plaited nooses made of sound leather and attached to ropes which are in lengths of about 50 to 60 yards. These ropes are pegged down, but not too strongly. The deer get their feet entangled in the nooses, drag up the pegs, and make off with a line of rope and nooses, but before going far they are pulled up by the bushes, and it is then that the fun begins for nets have to be employed. Stags are easier than hinds to net, for as a rule they lower their heads, and the horns get into the meshes, but the hinds use their feet and strike out violently.

'Once in the nets, the hard work is over, a collar with ropes on opposite sides is fixed on the neck, and the hinds can be led away. The stags have generally to be picketed on the spot, otherwise they plunge about and knock themselves and their captors out of time. In a day or two the deer will drink water in which parched flour has been mixed. They are easily tamed, and seldom die.

'Another way, but a laborious one is to catch the fawns before they can run. First they are fed on goat's milk squeezed from a sponge, then from a baby's bottle, and finally a nanny goat is a foster mother. Most of the deer at Pandrathan paddocks were thus reared. In captivity the *Hangul* breeds freely.'

About this species of deer in captivity Ward (1925) says :

'. . . . the herd wandered about in the day time and returned to their evening feed before dark. At night they were all housed in a shed which was surrounded by a fence in order to save them from leopards.

'. . . . after the farm and plantations increased, they had to be enclosed in paddocks where they have done well, and bred freely.

'Kashmir deer do very well in semi-captivity provided the enclosures are not too small, and part of it is roughly covered with stones, these are best placed near the fences where the animals mostly stand. If the ground of the paddocks is smooth and soft the hoofs will grow very long, and eventually have to be cut.

'The enclosures must be sufficiently large to allow of the deer running round, this they almost invariably do in winter especially when snow is falling.

'A variety of food is necessary, mulberry and hawthorn leaves are appreciated, sweet hay, lucerne, sugar-beet and turnips, also horse chestnuts cut into pieces—sugar-beet and carrots seem to be the favourite foods—bran and salt have to be provided but grain is not necessary, about two pounds of bran will suffice.

'. . . In September thick poles must be put into the ground in order that the velvet may be rubbed off by the deer, large branches may be thrown into the enclosure, which the stags will throw about and play with and thus aid the burnishing . . . . it should also be remembered that many gallons of water will be required every day for each animal, and if a hollow can be made where a mud bath can be got the captive deer will be greatly pleased.'

I am quoting these extracts in full, because the sources of them are difficult to find in a library, and almost impossible to obtain in any bookshop.

Of keeping this species in captivity at Woburn Abbey in Britain, the (twelfth) Duke of Bedford (1949) says :

'The *Hangul* or Kashmir stag is, of all the races of the Red deer, the one which is most sensitive to internal parasites and the one most incapable of being kept on grass. We had, however, a fine herd in a large yard, up to the time when the war led to their destruction.

'When elaphine deer are kept in a confined space it is necessary either to breed from very young stags only or, if adult stags are used, to saw off their horns ; otherwise they are very liable to injure their hinds in a fit of jealousy during the rut. The removal of a deer's hard antlers of course causes no pain, though it spoils his appearance for the rest of the season.

'The call of the Kashmir stag is somewhat intermediate between that of the wapiti and the European Red deer and I have seen it rather well described by the letters "Aaaungrieeeew" ! In other respects there is nothing particularly wapiti-ish about the *Hangul*, but it is a mistake to describe him, as some writers have done, as "exactly like" our Red deer. He is a grey beast rather than a red one ; his bay tine is normally longer than his brow and he rarely has much of a "cup". A 10-point head is the normal one and any greater number of points is far more unusual than in the case of the Red deer enjoying equally good feeding. Two Kashmir stags I have known were remarkable, one for a constitutional peculiarity, and the other for a mental one. The former was one of the first deer of the species we had and was tried on grass, with the result that he soon got into miserable condition and became a mere bag of bones. Notwithstanding this he grew an enormous pair of antlers which for length and width exceeded anything I have ever seen on one of his species. Usually ill-health and poor condition have a very adverse effect on a stag's horn-growth even if he is well-bred for antlerproduction. Incidentally a deer suffering from internal parasites can normally be restored to health by putting it in a gravel yard and feeding it on dry, nourishing food, with plenty of corn.

'The other Kashmir stag lived in a small paddock at the London Zoo and was remarkable for the fact that although a normally developed breeding animal, and none too amiable towards the human race, he showed no jealous ill-temper in the rutting season towards the young stags, his sons, who shared the same enclosure with him and his hinds. Anyone who knows anything about deer will realize that such amiability is astounding, and if possible even more remarkable than that of the park master-stag mentioned by Millais, who would allow himself to be photographed by his owner, in October, at a distance of a few feet ; and the fallow buck who, at the same season, would enter the house and lie down beside his master's chair ! '

VIII. RECOMMENDATIONS

I make the following recommendations :

1. That Lower and Upper Dachigam be constituted a sanctuary, and eventually a national park ; and that other activities such as sheep breeding, cattle grazing, firewood collecting, etc. be eliminated.
2. That the full control of Lower and Upper Dachigam be vested in one authority only, preferably the Forest Department, and that all rest houses, roads, etc. be under the jurisdiction of this one authority.
3. That the Kashmir Stag or *hangul* be given full, legal and effective protection wherever found, both inside and outside its sanctuaries.
4. That a scientific study and census be conducted by a competent ecologist to determine the exact status of the *hangul* and to make recommendations for better protection and management of the species.
5. That a number of *hangul* be captured and kept in captivity in a suitable enclosure somewhere near Srinagar, and also at Simla if a Himalayan Zoological Park materializes there.

IX. ACKNOWLEDGEMENTS

I am grateful to D. P. Dhar, the Home Minister of Kashmir, for his encouragement on several occasions ; and to G. Naqushbund, the Chief Conservator of Forests, for the co-operation of his Department. Also particularly to S. Atta Mohmad Khan, the Game Warden, for his help unfailingly given ; and to Rashid Wani, Soil Conservation Officer, for helping me on two visits to Lower Dachigam. And to Ujagger Singh (Range Officer), Ghulam Hyder (Head Game Watcher) and Qasem Wani (Second Game Watcher) for their interest and assistance to me.

And above all, I am indebted to that keen sportsman, H. H. the Maharaja of Kolhapur, for his help and encouragement in our joint effort to get the Kashmir Stag preserved for posterity.

X. Glossary of Local Terms

bakr-walla. a goatherd
barasingh(*a*). the Kashmir Stag in Kashmir, and the Indian Swamp Deer in Madhya Pradesh. (Lit. twelve horns)
gujar. a professional grazier
hangul. the Kashmiri name for the Kashmir Stag
rakh. a game preserve in the old days, in Kashmir
shou. the ' Sikkim ' Stag
tuj. the same as a ' pricket ' in British Red Deer : a young stag with its first and short, stick-like antlers

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Floral structure and stamens in *Ceiba pentandra* (Linn.) Gaertn.

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(*With seven text-figures*)

INTRODUCTION

Ceiba pentandra, a tropical Bombacaceous plant, popularly known as the Kapok or Silk Cotton tree on account of the silky floss produced in its capsules, is distributed in South America, West Indies, Tropical America, India, and Ceylon. It flowers in India and Ceylon during the colder months, from November to March every year.

From the aestivation of *Ceiba pentandra*, left- and right-handed flowers are distinguishable as is the case with most other species of Bombacaceae, perhaps all species of Malvaceae and Cochlospermaceae, and a few of Sterculiaceae, Linaceae, Caricaceae, Euphorbiaceae, Palmae, and Plumbaginaceae. In a tree, the two types of flowers are produced almost in the same proportion, and the percentage of the lefts does not differ significantly from that of the rights in any large flowering shoot or even a flower-cluster.

FLORAL ASYMMETRY

A fully-opened flower measuring about 5 cm. × 5 cm. has five white oblong petals which are connate at the base and downy externally. A petal is about 3 cm. long and 1 cm. broad. The petals are characteristically twisted, either clockwise or anti-clockwise, and this condition is more pronounced in the bud stage. In a *Ceiba pentandra* tree, the two types of flowers occur almost in the same proportion, a situation observed in many species of Malvaceae (Davis 1964). When viewed apically, a flower is considered left-handed (clockwise contorted aestivation) if the inner margin of a petal curves clockwisely towards the periphery, and right-handed if it curves counter-clockwisely. In Figure 1 are seen a right-handed and a left-handed flower. Even from a single petal it is possible to determine the direction of the petal-twist, since there is usually a mild depression and a colour-difference on it due to the overlapping of one of the neighbouring petals.

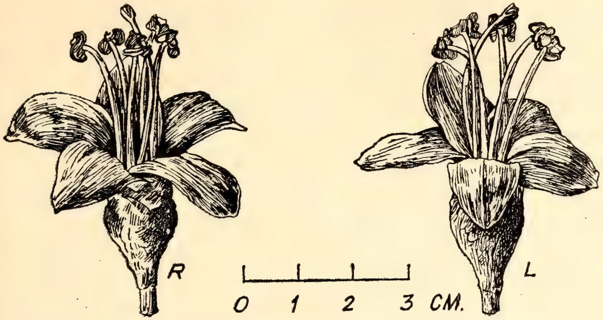

Fig. 1. Right- and left-handed flowers of *Ceiba pentandra*

Table I gives data on floral asymmetry from 8 trees, 4 from near Colombo and 4 from Calcutta. On the totals, the left- and right-handed flowers are almost equal with a slight excess for the left-handeds. But the difference is not statistically significant, $\left(\chi^2_4 = 6{\cdot}957\right)$. However, one tree produced significantly excess left-handeds. As this tree has the smallest number of flowers, perhaps with large samples equality for the two types of flowers could be expected. It may be mentioned in this connection that a significant excess of left-handed flowers was observed in *Hibiscus rosasinensis* in spite of very large samples collected throughout the year and from different places (Davis & Selvaraj 1964;

TABLE I

Ceiba pentandra: DATA ON AESTIVATION FROM 8 TREES

Date of observation	No. of trees	Aestivation		L+R	L—R	χ^2
		Left	Right			
18-12-1962	4	228	242	470	—14	0·4170
20-2-1964	1	53	30	83	23	6·3735
do.	1	139	140	279	— 1	0·0036
do.	1	192	181	373	11	0·3244
9-3-1964	1	192	178	370	14	0·5297
Total	8	804	771	1575	33	7·6482

$$\chi^2_1 = 0{\cdot}6914$$

$$\chi^2_4 = 6{\cdot}9568$$

Davis & Ghoshal *in press*). Further investigations are under way to get an explanation for the slight excess of the left-handers.

DISTRIBUTION OF LEFT- AND RIGHT-HANDED FLOWERS

1. *Between large flowering shoots.* The aestivation of the corolla of flowers from four *Ceiba pentandra* trees growing at Lunuwila, a village about 50 km. NW. of Colombo, Ceylon, was examined by the senior author on 18 December 1962 and the basic data are presented in Table II. From these trees altogether fourteen flower-bearing shoots were

TABLE II

Ceiba pentandra : LEFT- AND RIGHT-HANDED FLOWERS FROM 4 TREES (LUNUWILA, CEYLON, 18-12-1962)

1	L	41	L	81	L	121	L	161	L	201	L
2	L	42	L	82	R	122	R	162	L	202	L
3	L	43	L	83	R	123	R	163	L	203	R
4	L	44	L	84	R	124	R	164	L	204	R
5	L	45	L	85	L	125	L	165	R	205	L
6	L	46	L	86	L	126	R	166	R	206	R
7	R	47	R	87	R	127	R	167	R	207	L
8	R	48	R	88	L	128	R	168	R	208	R
9	L	49	L	89	L	129	R	169	L	209	L
10	L	50	R	90	L	130	R	170	L	210	R
11	L	51	R	91	R	131	R	171	L	211	R
12	R	52	R	92	R	132	R	172	L	212	R
13	R	53	R	93	R	133	R	173	L	213	L
14	L	54	L	94	L	134	L	174	L	214	L
15	L	55	R	95	L	135	L	175	L	215	L
16	L	56	R	96	R	136	L	176	R	216	R
17	R	57	R	97	L	137	L	177	L	217	L
18	L	58	L	98	R	138	R	178	R	218	R
19	L	59	L	99	R	139	R	179	L	219	R
20	R	60	L	100	L	140	L	180	R	220	R
21	R	61	R	101	R	141	R	181	L	221	R
22	R	62	L	102	R	142	L	182	L	222	L
23	R	63	R	103	L	143	R	183	L	223	L
24	R	64	R	104	L	144	R	184	R	224	L
25	L	65	L	105	R	145	L	185	R	225	L
26	R	66	L	106	L	146	L	186	L	226	R
27	R	67	L	107	R	147	R	187	R	227	R
28	R	68	R	108	R	148	L	188	R	228	L
29	L	69	R	109	R	149	L	189	R	229	R
30	L	70	L	110	L	150	R	190	L	230	R
31	R	71	R	111	R	151	L	191	L	231	R
32	L	72	R	112	L	152	R	192	L	232	R
33	R	73	R	113	L	153	R	193	L	233	R
34	R	74	L	114	L	154	L	194	L	234	L
35	R	75	R	115	L	155	L	195	R	235	L
36	L	76	R	116	R	156	L	196	L	236	R
37	L	77	R	117	L	157	L	197	L	237	L
38	R	78	L	118	L	158	R	198	L	238	L
39	R	79	R	119	L	159	R	199	R	239	R
40	R	80	R	120	R	160	R	200	R	240	L

241	R	281	R	321	R	361	R	401	R	441	R
242	R	282	R	322	L	362	R	402	R	442	R
243	L	283	R	323	L	363	L	403	L	443	R
244	L	284	L	324	R	364	L	404	L	444	R
245	R	285	L	325	R	365	L	405	R	445	R
246	L	286	R	326	L	366	L	406	L	446	R
247	R	287	L	327	L	367	L	407	L	447	L
248	R	288	R	328	L	368	L	408	L	448	L
249	L	289	R	329	L	369	R	409	R	449	R
250	L	290	R	330	L	370	R	410	R	450	R
251	R	291	R	331	R	371	R	411	L	451	L
252	R	292	L	332	L	372	L	412	L	452	L
253	R	293	L	333	L	373	L	413	L	453	R
254	R	294	R	334	R	374	L	414	L	454	R
255	L	295	R	335	R	375	L	415	R	455	R
256	L	296	L	336	R	376	L	416	L	456	R
257	L	297	L	337	R	377	R	417	R	457	L
258	R	298	R	338	R	378	R	418	L	458	R
259	L	299	R	339	R	379	R	419	L	459	L
260	L	300	R	340	L	380	L	420	L	460	L
261	L	301	R	341	R	381	L	421	L	461	R
262	L	302	R	342	R	382	R	422	R	462	L
263	R	303	L	343	R	383	R	423	L	463	L
264	L	304	L	344	L	384	L	424	R	464	L
265	L	305	L	345	R	385	L	425	R	465	L
266	R	306	L	346	L	386	R	426	L	466	L
267	R	307	R	347	R	387	R	427	L	467	L
268	R	308	R	348	L	388	R	428	L	468	L
269	L	309	L	349	R	389	L	429	R	469	L
270	L	310	R	350	L	390	R	430	L	470	R
271	R	311	L	351	L	391	L	431	R		
272	R	312	R	352	R	392	R	432	R		
273	R	313	R	353	L	393	L	433	R		
274	R	314	L	354	R	394	R	434	L		
275	R	315	R	355	L	395	L	435	L		
276	R	316	R	356	L	396	R	436	L		
277	L	317	L	357	R	397	L	437	L		
278	R	318	R	358	L	398	R	438	R		
279	L	319	R	359	L	399	R	439	R		
280	R	320	R	360	R	400	L	440	R		

lopped and the flowers examined branchwise. All the flowers (including flower-buds) of a shoot were accounted for before proceeding to another, and the number of flowers per shoot ranged from 25 to 60. Unfortunately, data on the actual number of shoots per tree, and flowers per shoot could not be maintained.

An examination of the flowers of the above trees showed a slight excess for the right-handeds but not significantly more, the χ^2 value being 0·417. In order to see whether any shoot bore a significant excess of one kind of flower or the other, the data are plotted on a control chart (Fig. 2) for the proportions of the lefts. The 470 flowers have been arranged into ten groups of 47 each. The central position of *p* (estimate of proportion of lefts) and the 3-sigma limits on either side of *p* were calculated, and the corresponding figures for each group plotted [values for $p=0{\cdot}494$, $p+3$ S.E. $(p)=0{\cdot}713$, and $p-3$ S.E. $(p)=0{\cdot}275$]. It is seen that all the points fall well within the acceptance limits. Another point of interest, incidentally, is that 4 points fall clearly below the central line and 4 above it while 2 are almost on the central line. So far as the present observations are concerned, the control chart suggests that, in the population, the lefts and rights are about in equal numbers on each flower-bearing shoot.

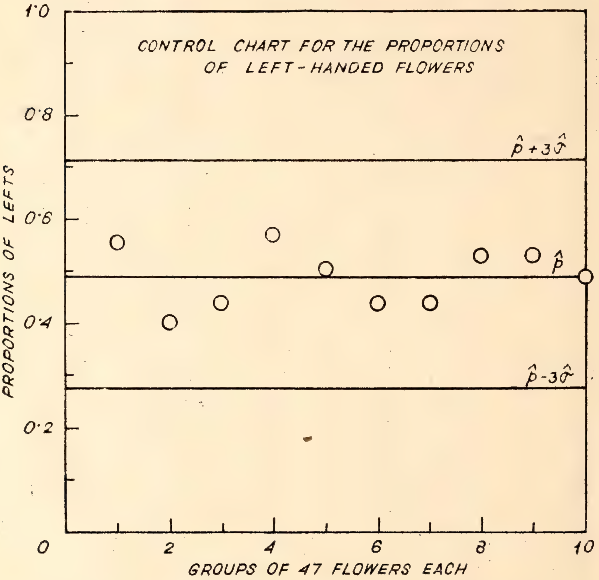

Fig. 2. Control chart for the proportions of the left-handed flowers

2. *Between flower clusters.* Flower buds in *Ceiba pentandra* appear in clusters from the axils of old or shed leaves at every branch tip. The tree is usually devoid of leaves while blooming. The inflorescence is normally a fascicle, and from the position and/or size it is possible to recognize the flowers according to the sequence of their production—in most Malvaceous species where the flowers are solitary and axillary it is more easy to follow the order of production. The aestivation of the corolla of the entire flowers sampled from 4 trees at Calcutta during the 1964 season was determined and recorded according to the order of their production for every fascicle. Solitary flowers and clusters bear-

ing two flowers were rejected. Data on those having three and four flowers per fascicle are given below :

TABLE III

Ceiba pentandra : FASCICLES OF 3 FLOWERS EACH

			Observed	Expected
L	L	L	7	6·3725
L	L	R	9	do.
L	R	L	6	do.
L	R	R	9	do.
R	R	R	2	do.
R	R	L	7	do.
R	L	R	8	do.
R	L	L	3	do.
			51	

Of the 51 fascicles, 4 belong to tree 1, 18 to tree 2, 23 to tree 3, and 6 to tree 4.

TABLE IV

Ceiba pentandra : FASCICLES OF 4 FLOWERS EACH

		Observed	Expected
4 R		1	1·6875
1 L	3 R	7	6·7500
2 L	2 R	10	10·1250
3 L	1 R	9	6·7500
4 L		0	1·6875
		27	

Of the 27 fascicles, 7 belong to tree 2, 13 to tree 3, and 7 to tree 4.

Inflorescences bearing five and more flowers are dealt with separately for each tree and the data are presented in Tables V to VIII. The χ^2 value and *p* value for each cluster are calculated. For tree 1, the χ^2 value with seven degrees of freedom is 2·206, for tree 2 with twenty-three degrees of freedom it is 22·245, for tree 3 with thirty-two degrees of freedom it is 25·414, and for the last tree with thirty-three degrees of freedom it is 29·760. It is clear from the above values that there is no suggestion that a fascicle produces significantly an excess of left-handed or right-handed flowers.

Since the number of flowers per fascicle is rather small, not exceeding 12, the application of the χ^2 test under such situation may not be

TABLE V

Ceiba pentandra, TREE 1: SPIRALITY OF FLOWERS ON DIFFERENT SHOOTS

Shoot No.	Flowers										L	R	p_{ij}
1	R	L	L	L	L	R	L	L	R	R	6	4	0·7538
2	L	R	L	L	R						3	2	1·0000
3	R	L	L	R	L	R	L				4	3	1·0000
4	R	L	L	L	L						4	1	0·3750
5	R	L	L	L	L						4	1	0·3750
6	R	L	R	L	L						3	2	1·0000
7	R	L	L	L	R	R	L	R	R	L	5	5	1·0000
8	R	R	L	L	R	L					3	3	1·0000
											32	21	

$$\chi^2_1 = 2{\cdot}283$$

$$\chi^2_7 = 2{\cdot}206$$

$$Q_1 = 4{\cdot}4887$$

TABLE VI

Ceiba pentandra, TREE 2: SPIRALITY OF FLOWERS ON DIFFERENT SHOOTS

Shoot No.	Flowers									L	R	p_{ij}
1	R	L	R	R	R					1	4	0·3750
2	R	L	L	L	R					3	2	1·0000
3	L	L	R	L	R	L	L			5	2	0·4531
4	L	L	R	R	R					2	3	1·0000
5	L	R	L	R	R	R	R			2	5	0·4531
6	L	R	L	L	L					4	1	0·3750
7	R	R	R	L	L	L	R			3	4	1·0000
8	L	L	R	R	L					3	2	1·0000
9	R	R	R	R	R					0	5	0·0625
10	R	L	L	L	L	R	R			4	3	1·0000
11	R	R	R	L	L	L				3	3	1·0000
12	L	R	L	R	L	R	L	L		5	3	0·7266
13	R	L	L	L	R	R	R	L	L	5	4	1·0000
14	R	L	R	R	L	R				2	4	0·6875
15	R	L	R	L	L	R	L	R		4	4	1·0000
16	R	R	L	R	L					2	3	1·0000
17	R	R	L	R	R					1	4	0·3750
18	L	R	R	L	L	L				4	2	0·6875
19	L	L	L	R	L	L	R	L		6	2	0·2891
20	R	R	L	L	R	R				2	4	0·6875
21	R	L	L	R	R					1	4	0·3750
22	R	L	R	L	R	R				2	4	0·6875
23	L	R	L	R	L	R				3	3	1·0000
24	R	R	R	L	L	L				3	3	1·0000
										70	78	

$$\chi^2_1 = 0{\cdot}432$$

$$\chi^2_{23} = 22{\cdot}245$$

$$Q_2 = 22{\cdot}6769$$

appropriate. Therefore, a more suitable test, the Pearson's Pλ test (Rao 1952) has been applied thus :

The exact probability of obtaining as large as or a larger deviation than the 1 : 1 ratio for the left-handers and right-handers is calculated

TABLE VII

Ceiba pentandra, TREE 3 : SPIRALITY OF FLOWERS ON DIFFERENT SHOOTS

Shoot No.	Flowers										L	R	p_{ij}
1	R	L	L	L	L	R	L				5	2	0·4531
2	R	R	L	R	L	R	R				2	5	0·4531
3	R	L	L	L	L	R					4	2	0·6875
4	R	L	R	L	L						3	2	1·0000
5	L	R	L	R	R	L					3	3	1·0000
6	L	L	L	R	R	L	R	L	L	R	6	4	0·7538
7	L	L	L	L	R	R					4	2	0·6875
8	L	R	R	R	R	R					1	5	0·2188
9	R	R	L	R	R						1	4	0·3750
10	R	L	R	L	L	L	R				4	3	1·0000
11	L	R	L	L	L	L					5	1	0·2188
12	R	R	R	L	L						2	3	1·0000
13	L	L	L	R	L	L					5	1	0·2188
14	L	R	R	L	R						2	3	1·0000
15	L	L	R	L	L	R	R	R			4	4	1·0000
16	L	R	R	R	L	R	R				2	5	0·4531
17	L	L	R	R	R						2	3	1·0000
18	R	L	R	R	L						2	3	1·0000
19	R	R	R	L	L	R	R				2	5	0·4531
20	L	L	R	L	R						3	2	1·0000
21	L	R	L	L	R						3	2	1·0000
22	L	L	R	L	L	L	R	L			6	2	0·2891
23	L	R	L	L	R						3	2	1·0000
24	L	L	R	R	L						3	2	1·0000
25	R	L	L	R	R						2	3	1·0000
26	L	R	L	L	R	R					3	3	1·0000
27	L	R	R	L	R	R					2	4	0·6875
28	R	L	L	L	R	L	R	R			4	4	1·0000
29	R	R	L	R	L						2	3	1·0000
30	R	L	R	R	L	R					2	4	0·6875
31	L	R	R	L	L	L	R				4	3	1·0000
32	L	L	R	R	L	R					3	3	1·0000
33	R	L	R	R	R						1	4	0·3750
											100	101	

$$\chi^2_1 = 0{\cdot}0049$$

$$\chi^2_{32} = 25{\cdot}4144$$

$$Q_3 = 25{\cdot}4193$$

for each observed shoot for each tree. For each tree, these exact probabilities are then pooled up. For the i-th tree on which k_i shoots are observed, if $p_{i1}, p_{i2}, \ldots, p_{ik_i}$ denote these probabilities, then the statistic $Q_i = -2\sum_{j=1}^{k_i} \log_e p_{ij}$ is distributed as a χ^2 with 2 k_i degrees of freedom. The statistic $Q = \Sigma_i Q_i$ is distributed as a χ^2 with 2 Σk_i degrees of freedom. Table IX gives the values of Q_i-'s and Q.

TABLE VIII

Ceiba pentandra, TREE 4: SPIRALITY OF FLOWERS ON DIFFERENT SHOOTS

Shoot No.	Flowers												L	R	p_{ij}
1	R	L	R	R	R	L	L	L	R				4	5	1·0000
2	L	R	R	R	L	R	L	R	L	R	R	R	4	8	0·3877
3	R	L	R	L	R	L	R	R					3	5	0·7266
4	L	R	L	L	R	R							3	3	1·0000
5	L	L	L	R	R	L	R	L	L	R			6	4	0·7538
6	R	L	R	L	L	L	L	L					6	2	0·2891
7	L	L	R	L	R	L							4	2	0·6875
8	R	L	R	R	L	L							3	3	1·0000
9	R	L	R	R	L								2	3	1·0000
10	R	R	L	R	R								1	4	0·3750
11	L	L	R	R	L	L							4	2	0·6875
12	R	L	L	L	L	R	L						5	2	0·4531
13	L	R	L	R	L	R	L	R					4	4	1·0000
14	L	L	R	R	R	R	L	R					3	5	0·7266
15	L	R	L	R	R	R	L	L	L	R	R		5	6	1·0000
16	R	R	L	L	L	L	R	L	R	L			6	4	0·7538
17	R	L	L	L	L	R							4	2	0·6875
18	R	L	L	L	L								4	1	0·3750
19	L	R	R	R	L	L	L	L					5	3	0·7266
20	R	L	L	L	R	R							3	3	1·0000
21	R	L	R	L	R	R							2	4	0·6875
22	R	R	L	R	L	L							3	3	1·0000
23	L	R	L	R	L								3	2	1·0000
24	L	L	L	L	R	L	L	L	L				8	1	0·0391
25	L	R	L	R	L	R	R	R	L	L	L		5	6	1·0000
26	L	R	R	R	R	L							2	4	0·6875
27	L	L	R	R	L	L	L	L	L	L	R		8	3	0·2266
28	R	R	R	R	L	L	R	R	L	L			4	6	0·7538
29	L	R	L	R	L	L	L	R					5	3	0·7266
30	L	L	L	R	L	R	L	R	R	L	L	L	8	4	0·3877
31	R	L	L	L	R	L	R	R	R	L			5	5	1·0000
32	R	L	L	R	R	L	R	R					3	5	0·7266
33	R	L	L	R	R								2	3	1·0000
34	R	R	R	L	L	R							2	4	0·6875
													139	124	

$$\chi^{2}_{1} = 0\cdot8555$$

$$\chi^{2}_{33} = 29\cdot7603$$

$$Q_4 = 30\cdot6158$$

In all the cases Q_i fell below the 5 per cent point of the corresponding distribution. It is thus seen that there is no evidence against the hypothesis of the 1 : 1 ratio between the left- and right-handed flowers in the various shoots for all the 4 trees observed.

TABLE IX

Tree No.	k_i	Q^i
1	8	4·49
2	24	22·68
3	33	25·42
4	34	30·62
	99	$Q = 83{\cdot}21$ d.f. $2\sum k_i = 198$

From the results of the foregoing different tests, it may be concluded that the left- and right-handed flowers of *Ceiba pentandra* are distributed in almost equal proportions within flower-clusters, between large flower-bearing shoots, and between trees in centres far away from each other. On the aggregate, there is a slight excess of left-handers, but the difference is not statistically significant. A similar situation was met with in *Bombax ceiba* (Davis *in press*). With *Hibiscus rosasinensis* and *Abutilon indicum* the differences (excess of lefts) were statistically significant. It may be recalled that the leaves of *Cocos nucifera* are arranged in five spirals running clockwise or anti-clockwise and, here again, the left-spiralled palms in a locality are slightly in excess of the right-handers and this character is not inherited (Davis 1962). However, in the Southern Hemisphere it is the right-handers that are in excess (Davis 1964a).

DEVELOPMENT OF THE PETAL-STAMEN CORD

By examining several transverse sections prepared in series of young as well as old flowers, especially of the androecium and corolla, which are partially fused at the base and therefore shed together when the flower withers, the following information was obtained.

At an early stage, the vascular traces separating from the central core, above the thalamus, can be easily made out. Ere long these separating traces form somewhat into a ring and a thick, mostly parenchymatous tissue surrounding these traces separates into the calyx. The calyx covers the corolla and the essential organs of the flower completely during the early stages of development. Due to the difference in the rates of growth of the calyx and the rest of the flower, the dome of the calyx ruptures along three to five lines, and these openings extend almost half the length of the calyx, thus distinguishing themselves into 3-5 sepals. Incidentally, the flowers of the 4 trees sampled possessed only four (about) sepals each.

At an early stage, enclosed by the calyx, may be seen a somewhat wavy ring having 10 prominent vascular traces distributed at regular intervals. The wavy ring assumes a pentagonal shape and this petal-stamen cord develops into the whorls of corolla and androecium. In figure 3 are given some stages of the development of the petals (as well

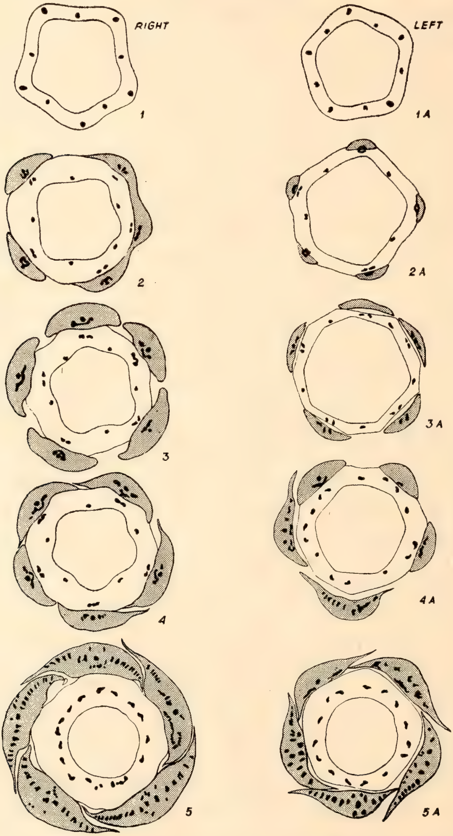

Fig. 3. Some stages in the development of the petal-stamen cords in right- and left-handed flowers

as the staminal ring) in a right-handed and a left-handed flower. In stage one may be seen the pentagonal petal-stamen cord with five prominent vascular traces at the corners and five relatively smaller ones between the corner ones. The corner traces undergo a tangential division once and the peripheral half of each trace forms the initial vascular trace of a petal. The inner half of each corner trace divides into two again, thus resulting in 15 traces for the rest of the ring. The vascular trace at the region of a future petal undergoes further divisions as the petal goes on expanding. By examining the divisions of the traces in the petals of several flowers, it was seen that in a left-handed flower more traces are formed towards the left half of the petal, and vice versa in a right-handed flower.

The petal initials at an early stage are located far away from each other (vide fig. 3 stages 2A and 3A) and are completely independent. Later on they are further fused with the rest of the ring which ultimately develops into the base of the staminal ring. However, in stage 2 of fig. 3, three petals appear to be united at the base. At stage 4, the petals tend to twist, one of their distal ends overlapping the petal either on its left or right, and this determines whether the corolla will have a clockwise or counter-clockwise contortion. We do not know yet the factor(s) responsible for the twisting of the petals of a particular flower clockwisely and another conversely. In figure 3 are seen a right-handed and a left-handed flower showing five main stages in the development of the petals up to the stage where their imbrication becomes clear.

Development of the Stamens

In stage 1 of figure 4 is seen the staminal ring possessing fifteen vascular traces. This is the stage just after the differentiation of the petals from the rest of the staminal ring. One vascular trace each from two adjoining corners and the undivided one located between them form the basis for a single stamen. Thus, the fifteen traces go to form the five stamens, on account of which the species is perhaps named *C. pentandra.* Up to stage 4, the filaments of the stamens are united and, beyond, the three vascular traces of a stamen fuse together end-to-end. These traces gradually curve (concave outside) resulting in the formation of a prominent groove on the peripheral face of each filament. From the fifth stage, the filaments are free and each of them bears three almost reniform anthers at its tip. Each trace connects an anther, and the flower has 15 anthers in all. Cobley (1957), however, mentions that the staminal tube divides at its apex into from five to ten parts, each part bearing a twisted one-celled anther.

In figure 5 are seen some of the abnormal forms of stamens. The fifteen anthers are usually borne on five filaments, but rarely the filaments may split or fuse in various ways resulting in two to ten distinct stamens per flower. A stamen may have only one anther supported by a filament whose width is about a third of a normal filament. Presumably this filament has only one of the usual three vascular traces. Another stamen may have two anthers, others may possess anthers ranging up to 10. No combined filament having more than 10 anthers was noticed. Also, no flower was met with where all the filaments remained fused up to the anthers into a monadelphous tube.

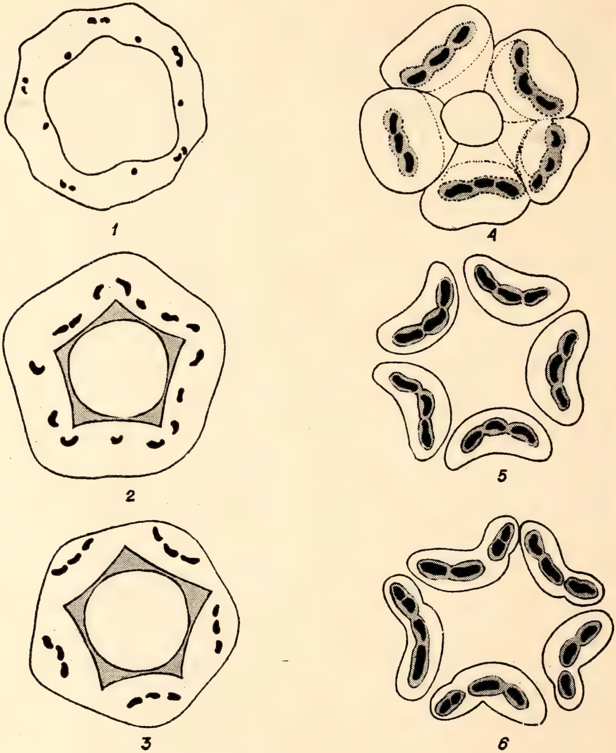

Fig. 4. Six stages in the development of the androecium in *Ceiba pentandra*

As these abnormal types of stamens are rather common, their occurrence was estimated for a population of 100 flowers per tree for the four trees (only 75 flowers from tree 1). Data on the left- and right-handed flowers were accounted for separately as may be seen in Table X. Free

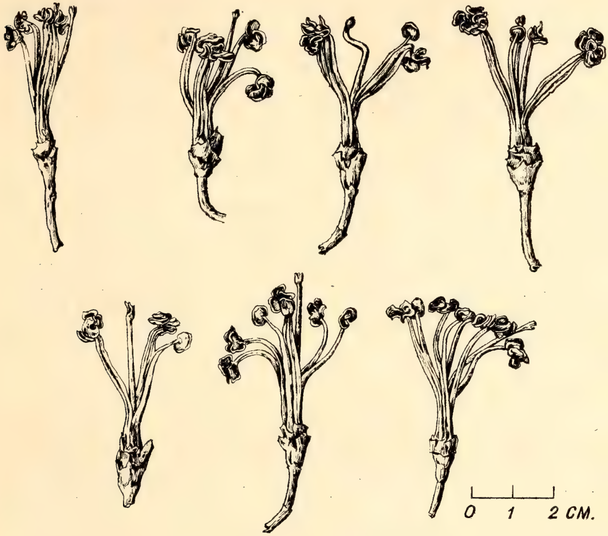

Fig. 5. Flowers showing abnormal combinations of stamens

TABLE X

Ceiba pentandra : PARTICULARS ON FLORAL ORGANS

Tree No.	Flowers	Stamens				Petals		Sepals
		Free	Double	Treble	Others	Normal	Short	
				Left-handers				
1	41	193	8	—	—	141	65	152/41
2	50	215	21	3	—	232	17	178/43
3	50	218	17	1	2	227	24	188/43
4	50	230	11	2	—	249	—	155/38
Total	191	856	57	6	2	849	106	673*
Mean		4·482	0·298	0·031	0·010	4·445	0·555	4·079
				Right-handers				
1	25	109	5	4	—	95	31	81/20
2	50	210	14	4	1	238	13	176/44
3	50	227	14	1	—	205	45	169/40
4	50	211	14	2	—	250	—	168/41
Total	175	757	47	11	1	788	89	594**
Mean		4·326	0·269	0·063	0·006	4·503	0·509	4·097

*Total sepals for 165 flowers ; **Total sepals for 145 flowers stamens are those that have one to three anthers (mostly three) and the filaments are distinct up to the base where all are united. Double stamens possess more than three anthers but not exceeding 6, and treble ones possess anthers ranging from 7 to 9. It may be seen from Table X that both the lefts and rights possess almost the same number of stamens, free as well as the other combinations. The rights have a slightly smaller figure for the free stamens, but the difference is not statistically significant.

SIZE OF POLLEN GRAINS

The size of the pollen grains was estimated for a few flowers from only one tree. Two hundred normally developed pollen grains each of six flowers were measured. Though a pollen grain of *Ceiba pentandra* is somewhat spherical, its trigonous form is distinguishable; the distance between two corners was measured and the data are given in Table XI.

TABLE XI

Ceiba pentandra : SIZE OF POLLEN GRAINS

Flower No.	Mean length of pollen		Variance of pollen	
	Dry	Soaked	Dry	Soaked
1	54·1904	62·4272	18·1364	90·9552
2	53·2356	61·2788	29·6460	60·4419
3	55·7700	61·8156	11·7109	52·3920
4	53·1476	65·0452	22·6280	31·4813
5	51·4096	61·4460	18·7792	36·7375
6	54·8152	60·7420	21·0772	141·2312

Measurements of dry pollen were taken a few hours after the pollen grains were extracted from the anthers. Further quantities of the dry pollen grains were soaked in distilled water and measurements were made when they swelled to their maximum, to find out the percentage increase in the size of dry pollen. Variances for the values for the dry and soaked pollen grains were also calculated. The over-all mean length of dry pollen grains was found to be 53·7680μ, and that for soaked pollen 62·4448μ. Nair (1962) gave the equatorial diameter of *Eriodendron anfractuosum* (*Ceiba pentandra*) pollen as 60μ. There is an increase in size of 16·14% when a dry pollen grain swells in water.

In another set of six flowers, the percentage sterile (infertile or underdeveloped) pollen grains was estimated by treatment with 1% acetocarmine solution. The data as given in Table XII show that the particular flowers examined bore 35·95% infertile pollen grains.

MORPHOLOGICAL VARIATIONS

A few peculiarities were observed in some flowers of *Ceiba pentandra* which are mentioned below.

TABLE XII

Ceiba pentandra : STERILE AND FERTILE POLLEN

Flower No.	Sterile	Fertile	Total
1	25	92	117
2	11	105	116
3	31	76	107
4	30	80	110
5	26	103	129
6	60	53	113
	183	509	692

% sterile pollen = 35·95

In an appreciable number of flowers of three trees, one or more petals (all petals in some) remained very short ; this is due to certain congestion operating inside the calyx tube at an early stage of unfolding of the petals. However, the stamens and style emerge undisturbed to their normal length. The flower in Fig. 6, E has all the five petals affected, while in flower D only two are short, the remaining three petals spreading to their

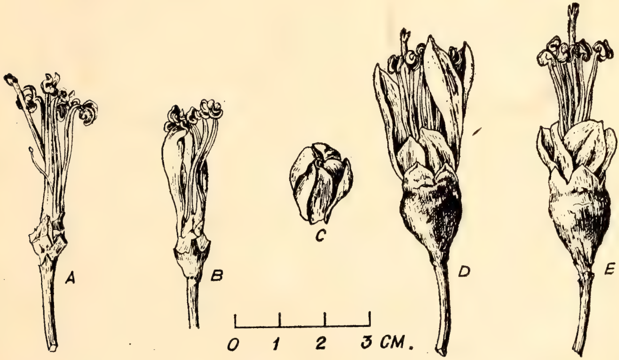

Fig. 6. Some abnormal flowers of *Ceiba pentandra*

A. Flower with an additional ovary ; *B*. Flower showing a petaloid stamen ; *C*. Flower with six petals ; *D*. and *E*. Flowers with some or all petals compressed normal length. 14·67% of the petals from flowers of the three trees showed this peculiarity. However, one tree was absolutely free from this compression of petals. Further details on this may be seen in Table X.

In one flower the aestivation of the petals was imbricate with one petal completely in and one of its immediate neighbours completely out. The three others showed regular twisting (Fig. 7, B).

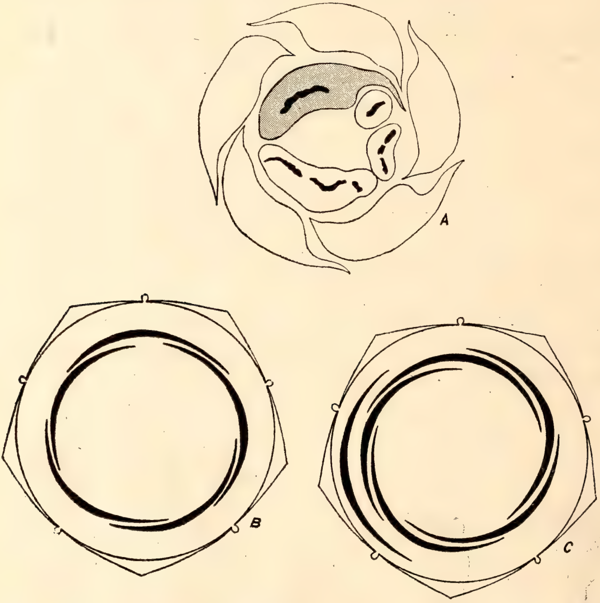

Fig. 7. Partial floral drawing of some abnormal flowers of *Ceiba pentandra*

In another flower (Figs. 6, C and 7, C) an extra petal was observed. The five petals which formed the normal corolla twisted anti-clockwise and the sixth petal, which was completely out, was located between the calyx and normal corolla.

A petaloid stamen was also noticed in one flower (Figs. 6, B and 7, A). One of the four filaments of this flower flattened considerably and assumed the shape and size of a petal. There was no trace of an anther on this petaloid stamen unlike those in many petaloid stamens of *Hibiscus rosasinensis* or even *Bombax ceiba* (Davis & Mariamma 1965).

Additional ovary was observed in another flower (Fig. 6, A). The flower had the usual syncarpic ovary comprising five pistils which were fused upto the stigmatic end. An extra carpel free from the rest, though underdeveloped, grew from the base of the normal ovary. This carpel had an independent style and stigma.

ACKNOWLEDGEMENT

We thank Shri S. K. De, Artist, Crop Science Unit, Indian Statistical Institute, Calcutta, for the illustrations.

SYNOPSIS

The corolla of *Ceiba pentandra*, typical of Bombacaceae, is contorted, all the five petals in one flower twisting clockwise and in another counter-clockwise. The left- and right-handed flowers of this species are distributed in a 1 : 1 ratio within flower clusters and within large flower-bearing shoots, as well as between trees in centres very far from each other. The development of the petals and stamens was studied in the two kinds of flowers. But the mechanism which regulates the asymmetry in the corolla could not be known.

The two kinds of flowers bore similar numbers of stamens, both free and combined ones.

The size of the pollen grains was estimated.

14·67% of the petals of flowers from three trees failed to unfold properly.

A few flowers showing striking variations are also briefly described.

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Critical Notes on three species of *Capparis* Linn. from peninsular India

BY

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Botanical Survey of India, Poona

(*With a map and four plates*)

The genus *Capparis* Linn. is represented by nearly twenty species in western and peninsular India of which only six, namely *C. spinosa* Linn., *C. heyneana* Wall., *C. decidua* Edgew., *C. grandis* Linn. f., *C. sepiaria* Linn., and *C. zeylanica* Linn., are of some medicinal importance. Recently, in addition to these, *C. moonii* Wt., practically unknown until now for its virtues as a medicinal plant, has claimed prominence as a drug in the treatment of tuberculosis and skin ailments. However, the existence of contrary views on its efficacy as a drug suggested that there was considerable confusion on the botanical identity of the material dealt with, and that a mixture of two or more species of *Capparis* was involved in the clinical investigations. Against this background the present investigation was taken up with particular emphasis on *C. moonii* and a detailed note on the correct botanical identity and various aspects of the clinical studies made has recently been published (Rolla Seshagiri Rao & R. Sundara Raghavan, 1964, *J. Sci. Industr. Res.* **23** : 53).

During these studies it was observed that considerable ambiguity existed on the botanical identity of two species closely related to *Capparis moonii* Wt., namely *C. roxburghii* DC. and *C. cleghornii* Dunn. From the literature it is clear that many earlier workers, namely Graham, Dalzell, Gibson, Talbot, and Cooke, confused *C. moonii* with *C. roxburghii* and these two species with *C. cleghornii.* Cooke's description of *C. roxburghii* DC. is probably based on a mixture of *C. cleghornii* and *C. moonii*, and a scrutiny of the few sheets identified as ' *C. roxburghii* DC. ' in the collections of Cooke and Talbot confirmed that these are all referable to *C. moonii* Wt. only. The available herbarium sheets for these three species are scanty, and a reference to the various Indian herbaria revealed that *C. cleghornii* was not represented in any of the collections. It may be pointed out that *C. cleghornii* has not been collected since 1846 when Cleghorn collected this species at Ballalrayandurga (Mysore State) for the first time. According to Dr. Jacobs of the Rijksherbarium, who is at present working on a monograph of

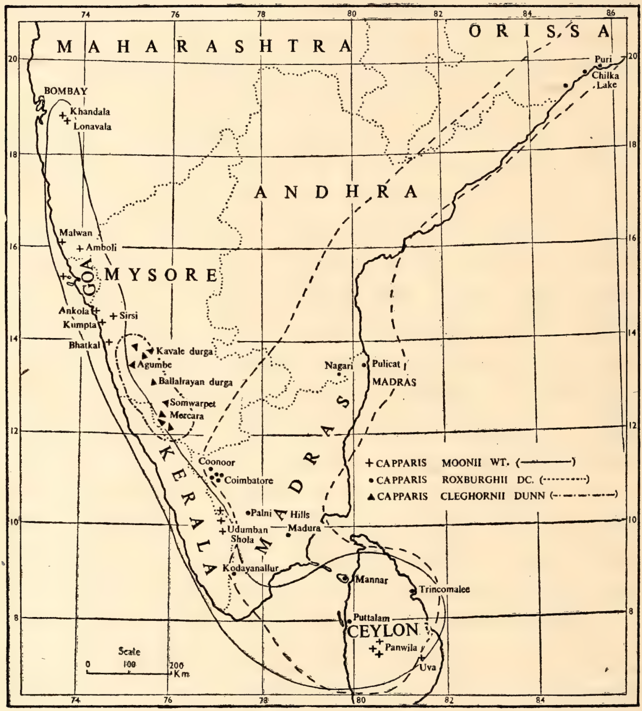
Capparaceae, both *C. cleghornii* and *C. roxburghii* are poorly represented at Kew, and he could not examine any fruits of *C. cleghornii.*

The present study is based on extensive field observations during the last two years supplemented with a critical study of the herbarium specimens available in the Central National Herbarium, Calcutta, Blatter Herbarium, Bombay, and the regional herbaria of the Botanical Survey of India at Poona and Coimbatore. Topotypes of *C. cleghornii* have been collected from Ballalrayandurga in Mysore State in February-March 1963, and a photograph of the type of this species obtained from Kew has also been studied with reference to these collections.

Much of the confusion is due to the incomplete nature of the specimens collected at any one time and the poor preservation of the flowers. The degree of pubescence, the density of the stipular spines, and the size, shape, and venation of the leaves are extremely variable characters depending on the age of the plants and whether they are collected from young twigs or older branches. The flowering shoots are conspicuously different from the fruiting branches and, coupled with this, the flowers are ephemeral—the sepals and petals being caducous are not properly preserved in the herbarium specimens. For instance, the unequal petals of *C. cleghornii* spreading like the wings of a butterfly (Plate III, Photograph B), the one character that readily differentiates this species from the other related species in the field, can never be visualized from herbarium specimens alone.

On the basis of our observations it may be stated that these three species are quite distinct. *C. moonii* can be distinguished from the other two by the larger size of its leaves, flowers, and fruit. *C. roxburghii* can be separated from the rest by its globose orange-yellow fruit, thin pericarp, and smaller seeds. *C. cleghornii* differs from the allied species by the fulvous pubescence of the buds, the markedly unequal petals, the slender stalks supporting the fruits, and the small globular fruits with distinct sharp conical projections at the top and containing fewer seeds, varying from one to four. Except for the flower size, *C. cleghornii* has a closer affinity to *C. moonii* than to *C. roxburghii.*

The distribution of these three species is equally interesting. *C. moonii* is very common along the Western Ghats in the moist deciduous and semi-evergreen forests of Maharashtra, Mysore, Kerala, and the coastal islands off the west coast, extending to Ceylon. It is common from almost sea-level to 800 m. in regions of moderately high rainfall ranging up to 300 cm. per annum. On the other hand, *C. roxburghii* is abundant along the Eastern Ghats in the deciduous forests of Orissa, Andhra, and Madras, extending south to Ceylon. It is confined to lower elevations and to areas of less rainfall, ranging from 100 to 150 cm. per annum. Unlike the other two, *C. cleghornii* is confined to the eastern slopes of the Western Ghats in the Mysore State. It is invariably seen on the outskirts of evergreen forests in cleared forest areas at an altitude ranging from 700 to 1400 m. with rainfall varying from 300 to 800 cm. per annum (Map).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▲ CAPPARIS CLEGHORNII DUNN (-·-·-·-)

Map showing distribution of *Capparis moonii*, *C. roxburghii*, and *C. cleghornii* in peninsular India

A key to the identification of these three species and a detailed description of these species is given below :

KEY TO FLOWERING SPECIMENS OF *Capparis*

A. Young shoots fulvous-pubescent, petiole and midrib purplish, nerves 6-8 pairs, lamina 4-7 cm. long, 2·5-3 cm. broad ; flower buds 1·8 cm. across or less, puberulous or glabrous ; petals about equal or very unequal, veins diverging from base, with or without a prominent median vein ; stamens less than 80, spreading, 3-4·5 cm. across

B. Tender leaves pinkish, drying reddish brown, midrib and lamina puberulous abaxially, later glabrous ; twigs evidently spiny ; flower buds fulvous-pubescent ; petals very unequal, with veins diverging from base without a median vein ; stamens 65-80 ; ovules few, less than 10.......................... ....*C. cleghornii*

BB. Tender leaves green, drying green, glabrous on both surfaces ; twigs scarcely spiny ; flower buds glabrous ; petals about equal, with veins diverging from base, and with a prominent median vein ; stamens 45-50 ; ovules many, more than 30..*C. roxburghii*

AA. Young shoots glabrous or hoary, petiole and midrib green, nerves 6-16 pairs, lamina 7-10 cm. long, 3-4·5 cm. broad, flower buds about 2·5 cm. across, hoary, later glabrescent ; petals about equal, with veins diverging from base without a prominent median vein ; stamens over 150, spreading 7-10 cm. across..*C. moonii*

KEY TO FRUITING SPECIMENS OF *Capparis*

A. Mature fruits ovoid or globose, conspicuously umbonate, less than 5 cm. long, the fruit stalk (of combined gynophore and pedicel) slender, cylindrical ; pericarp thin, hard ; endocarp scarlet ; seeds few (1-4) ; cotyledons acute...*C. cleghornii*

AA. Mature fruits globose or sub-globose, emarginate or slightly umbonate, more than 5 cm. long, the fruit stalk (of combined gynophore and pedicel) quite stout, cylindrical or prominently callose at tip ; pericarp thin or woody ; endocarp scarlet or white ; seeds many ; cotyledons acute or obtuse

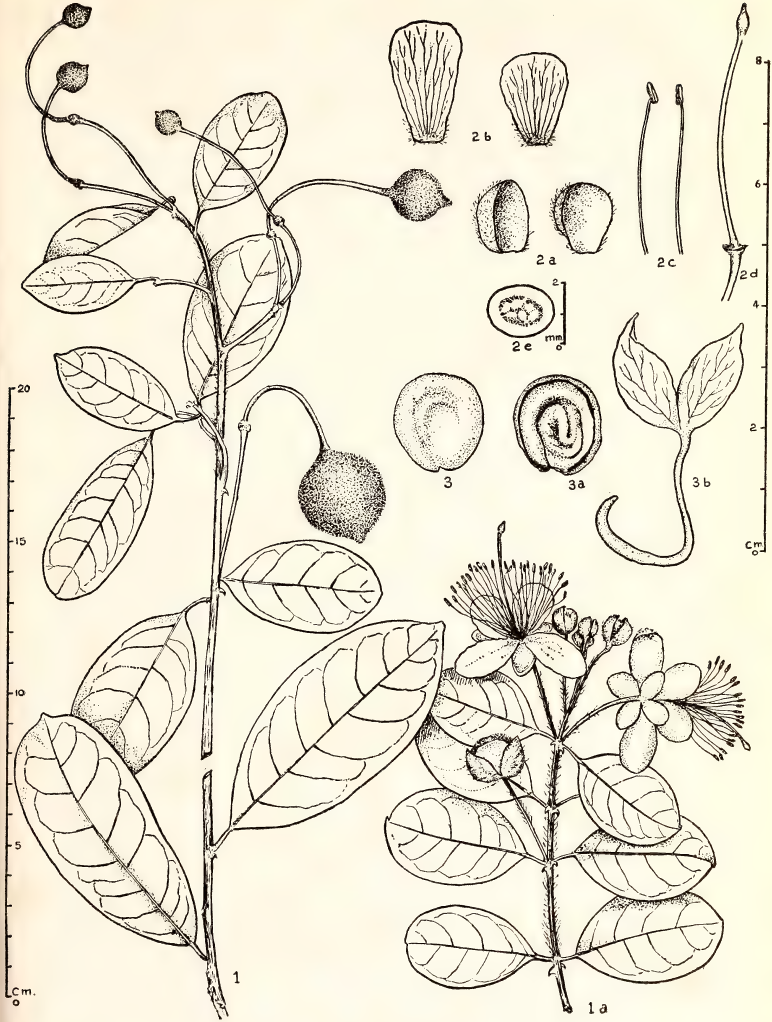
B. Leaf 10-16 cm. long, 4-5·5 cm. broad ; twigs conspicuously spiny ; few fruits (mostly 1-3) developing from a corymb ; fruits reddish brown, emarginate about 13 cm. long, 10 cm. across, tip of stalk usually forming a callosity ; pericarp woody, hard ; endocarp white, later turning scarlet ; seeds 40-45, obovoid, 16-18 mm. long, and 12-15 mm. broad ; embryo curved, cotyledons acute...*C. moonii*

BB. Leaf 5-7 cm. long, 2-3 cm. broad, twigs scarcely spiny, 5-7 fruits developing from a corymb ; fruits orange-red, emarginate, apex umbonate, 5-6 cm. across, tip of stalk never callose ; pericarp thin, crustaceous ; endocarp creamy, seeds 35-40, obovoid about 10-12 mm. long, 9-10 mm. broad ; embryo contorted, cotyledons obtuse......... ....*C. roxburghii*

C. cleghornii Dunn in Gamble, Fl. Madras 1: 46, 1915, *nomen nudum* ; Kew Bull. 61, 1916 ; Blatter, Jour. Bombay nat. Hist. Soc. 31 : 905, 1927. *C. roxburghii* DC. Hook. f. & Thom. in Fl. Brit. Ind. 1 : 175-76, 1875, *pro parte, excl. syn.*

Armed climber ascending 6-8 m., stem about 10 cm. in diameter at base, profusely branching ; young shoots flagellate, red-purple tinged, noticeably fulvous pubescent, older shoots puberulous ; stipular spines stout, short, recurved, evident throughout. *Tender leaves* pinkish when fresh, drying reddish brown, glabrous adaxially, minutely puberulous abaxially ; leaves in flowering shoots smaller than in fruiting branches, 1·2-2·2 times as long as broad, in fruiting shoots 1·8-2·4 times as long as broad, about 3·5-10 cm. long, 2-4·5 cm. broad ; petiole reddish, pubescent, 6-10 mm. long, lamina elliptic or obovate, subcoriaceous, glabrous, both surfaces opaque, base narrowed, apex acute, obtuse or shortly abruptly bluntly acuminate, occasionally retuse ; venation indistinct ; midrib dorsally emphatic, flat or channelled, pinkish, minutely puberulous, ventrally obscure, flat, glabrous ; secondary ribs 4-6 (7) pairs, divaricate. *Inflorescence* mostly terminal (occasionally axillary), corymbose, fulvous pubescent, 6- to 10-flowered, often axillary and solitary in subterminal shoots gradually merging into the corymb ; pedicels slender, tomentose, lowermost pedicel about 3·5 cm. long. *Flower buds* globose, 6 mm.-1·8 cm. across, densely fulvous pubescent, bracteate, the bracts spiny. *Flowers* white, showy, 3·5-4·5 cm. across in full bloom, the unequal pair of petals spread out like butterfly wings. *Sepals* four, subequal, concave, two seriate, imbricate, caducous, densely pubescent outside, glabrous within, almost similar in size and shape, about 10-12 mm. long, 10 mm. wide. *Petals* four, white, rosy on ageing, caducous, puberulous near the base, in two unequal pairs, the outer two larger, obovate oblong, about 2·2-2·5 cm. long, 1-1·2 cm. broad, the inner petals obovate, nearly 1·6-1·8 cm. long, 1·2-1·4 cm. broad, prominently veined, veins diverging from base, dichotomously branched. *Stamens* approximately 65-80 spreading from base of gynophore ; filaments slender, 2·2-2·5 cm. long, white, purple on ageing ; anthers introse. *Pistil* on a slender gynophore, glabrous ; gynophore 3-3·5 cm. long ; ovary ovoid, glabrous, purple, about 3-3·5 mm. long, 2 mm. across, unilocular ; style obsolete ; stigma capitate ; ovules few (8-10 only) on 3 parietal placentae. *Fruits* baccate, indehiscent, 4-5 developing in a corymb, erect at first, pendant at maturity on a slender elongated stalk, the jointed peduncle and gynophore 6-8·5 cm. long, stalk of gynophore gradually thickening from the base above, never callose at its tip ; fruits ovoid or subglobose, 3-4 cm. long, 2-3 cm. across, apex prominently umbonate, greenish when young, dark violet-purplish when ripe ; pericarp thin, hard ; endocarp pulpy, deep scarlet. *Seeds* reddish brown, few, 1-4, dorsally compressed large, obovoid or suborbicular about 1·5-1·8 cm. long, 1·4-1·5 cm. across ; testa crustaceous ; embryo coiled, cotyledons foliaceous, folded, about 18-20 mm. long, 7-8 mm. wide, elliptic, acute ; radicle thick (Plate I and Plate III, C 1).

Ver. names (Kanarese) : *Malaithottinkai, Baduhugli, Badumungri* (as used in Agumbe area) ; *Nayikaremanjehannu* (as used in Coorg area).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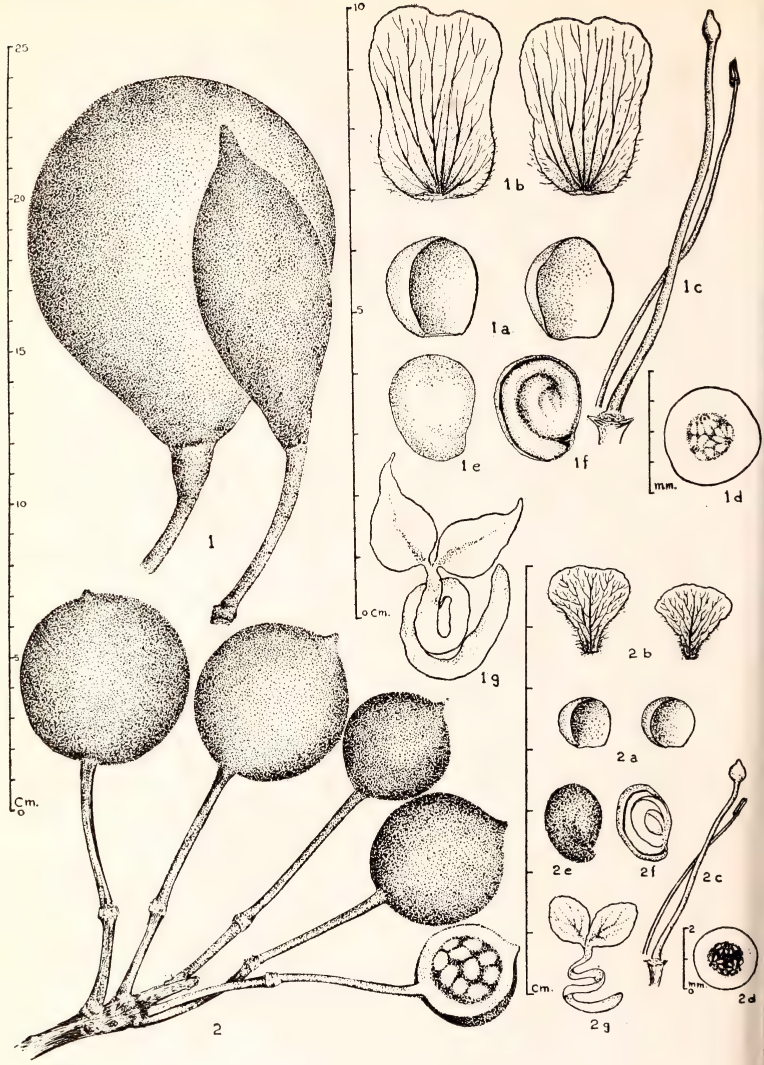
Capparis cleghornii Dunn

1. A fruiting twig; 1a. A flowering twig; 2a. Outer and inner sepals; 2b. Outer and inner petals; 2c. Stamen; 2d. Pistil; 2e. Ovary in cross-section; 3. Seed; 3a. Seed with testa partly removed showing embryo *in situ*; 3b. Embryo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Capparis moonii Wt.

1. Immature and mature fruits showing variations in shape; 1a. Outer and inner sepals; 1b. Outer and inner petals; 1c. Pistil and stamen; 1d. Ovary in cross-section; 1e. Seed; 1f. Seed opened to show embryo *in situ*; 1g. Embryo

Capparis roxburghii DC.

2. A fruiting twig with an immature fruit cut longitudinally; 2a. Outer and inner sepals; 2b. Outer and inner petals; 2c. Pistil and stamen; 2d. Ovary in cross-section; 2e. Seed; 2f. Seed cut open showing embryo *in situ*; 2g. Embryo

Habitat. This species grows on rocky slopes in the outskirts of evergreen forests mostly in cleared forest areas. It is of considerable interest to record that this species is very commonly associated with *Mezoneuron cucculatum* Wt. & Arn., *Wagatea spicata* Dalz., *Elaeagnus conferta* Roxb., and *Eurya japonica* Thunb. in Mysore State.

Flowering and fruiting. Flowers develop usually in early March with the first summer showers and continue to first week of April. Anthesis takes place in the evenings and in the early morning and within a short time the floral parts fall off one after another leaving only the ovary with gynophore. Fruiting takes place from April to July and fully mature fruits are common in August.

Uses. The fruits are eaten in Coorg district.

Specimens examined. Balalroydroog, India (misspelt for Ballalarayanadurga, Mysore State), *Cleghorn* D. 176, 13th April 1846, *holotype* (K). The photograph of the type sent from Kew was examined by the authors and the important characters of the species have been well made out. (Plate III A). (Subsequently, in 1964, Rolla S. Rao examined the type at Kew.)

MYSORE STATE :

Chikmagalur district : Ballalrayandurga, *A. S. Rao* 85349 (BSI) ; *Sundara Raghavan* 86819, 86822, 86945, 86970 (BSI).

Coorg district : Mercara, *A. S. Rao* 74599, 85569, 85641 (BSI) ; Nalknad Palace, *A. S. Rao* 85955 (BSI) ; Somwarpet, *A. S. Rao* 85481 (BSI) ; Talacauvery, *A. S. Rao* 85748 (BSI).

Hassan district : Bisle-Hassan ghats, *Mahajan* 34816 (BSI).

Shimoga district : Agumbe, *Sundara Raghavan* 74216, 80554, 80629, 85312, 86341, 90289, 90391, 97237, 97302 (BSI) ; Gubbiga near Yedur, *Sundara Raghavan* 80826, 86222, 90153, 97096 (BSI) ; Hulical, *Sundara Raghavan* 80925 ; Kavaledurga, *Sundara Raghavan* 80943, 96956 (BSI) ; Kimmane, *Sundara Raghavan* 81085 (BSI).

Distribution. The distribution of this species seems to be very restricted. Though the species was first described in 1916, the data on distribution are quite meagre as the species was not re-collected for over a century. A good survey of the region between the Western Ghats and Bababudan Hills of Mysore State including Coorg area, with an altitudinal range of 700 to 1400 m. and a rainfall range of 350 to 800 cm. per annum, clearly shows that *C. cleghornii* is fairly well distributed in the evergreen forests of the various districts in this region. This species has not been recorded beyond this area.

Remarks. From the photograph of the type sheet of *C. cleghornii* it is clear that two labels, one for *Cleghorn D* 176 attached to the upper part of the sheet and the other for *Wight Herb. Kew Distr. no.* 68, 1866-67, attached on the lower part are involved for identical set of collections, all of them distinctly *C. cleghornii* Dunn, with tomentose flower buds. It is also equally clear that Cleghorn and Wight did not collect the material at the same time and from the same area. Cleghorn did collect from Ballalrayandurga in Mysore State, but Wight never collected anywhere in these areas. Accordingly the reference to Kew Distr. no. 68 attached to these specimens from the Wight Herb. appears to be in error. Further, a sheet in the Central National Herbarium, Calcutta, with an identical label ' Wight Herb. Kew Distr. no. 68, 1866-67 ' and carrying no other labels, on a detailed scrutiny was found to be *C. roxburghii* DC. (Plate IV, B). Accordingly an enquiry was addressed to the Royal Botanic Gardens, Kew, who clarified that ' Kew Distr. no. 68 ' actually referred to *C. roxburghii* collected by Wight from Pulicat and Nagari Hills near Madras and under the same number *C. cleghornii* was also distributed but no locality was known for it. It would appear that Dunn, at the time he described *C. cleghornii*, did not verify this confusion of two different species distributed under the same Kew Distr. no. 68. He had also not indicated the mixture of specimens of *C. cleghornii* under two different labels in the same sheet though he had noted at the bottom of the sheet the name of the new species and cited Wight Herb. Kew Distr. no. 68 also along Cleghorn's collection (Cleghorn D. 176) in his description. On the present evidence it seems likely that an extra label of Wight Kew Distr. no. 68 has been wrongly attached to the sheet bearing Cleghorn's specimens in Wight Herbarium. From the recent studies, the known distribution of *C. cleghornii* is limited to the Western Ghats of Mysore State only and does not extend any further.

The various characters and citations given by Hooker f. & Thomson (loc. cit.) under *C. roxburghii* DC. apply to that species only, but there is one character, ' buds usually tomentose ', which belongs to *C. cleghornii* as the buds of *C. roxburghii* DC. are distinctly glabrous. The characters given by Cooke under ' *C. roxburghii* DC.' are applicable to both *C. moonii* and *C. cleghornii*, and in the localities mentioned by Cooke only *C. moonii* grows in abundance. Since Cleghorn's collection of the species in 1846, the present series of collections made by the Botanical Survey of India during 1960-63 are the first of their kind.

Capparis roxburghii DC. Prod. 1 : 247-248, 1824 ; Wt. & Arn. Prod. 26, 1834 ; Wt. Icon. t. 1048, 1846 ; Hook. f. & Thoms. in Fl. Brit. Ind. 1 : 175-76, 1875 *pro parte* ; Trimen, Fl. Ceyl. 1 : 62, 1893 ; Dunn in Fl. Pres. Madras 1 : 44-45, 1915 ; Haines, Bot. Bihar & Orissa 1 : 32, 1921. *C. corymbosa* Roxb. Hort. Beng. 93, 1814 *nomen nudum* ; Fl. Ind. 2 : 569 (Carey's edition 1832) non Lamk.

Armed scandent shrub about 2-4 m. high, much branched from a little above base, base 8-10 cm. in diameter ; young shoots flagellate, fulvous-pubescent, stipular spines few or wanting, older shoots glabrous, purplish, spiny ; spines recurved, short, geminate. *Leaves* in flowering and fruiting shoots almost of same size, 1·8-2·5 times as long as broad, 4·5-8 cm. long, 2·5-3·5 cm. broad ; petiole reddish, glabrous, 1·3-2 cm. long ; lamina variable in size and shape, ovate or elliptic, subcoriaceous, glabrous, lustrous adaxially (sometimes dull in herbarium specimens), opaque abaxially, base cuneate, apex obtuse, acute or imperceptibly bluntly acuminate ; venation indistinct ; midrib dorsally emphatic, purplish, ridged, glabrous, ventrally obscure, sunken, flat or channelled ; secondary ribs 5-6 pairs, obscure, ascending or divaricate. *Inflorescence* terminal, corymbose (sometimes sub-umbellate), fulvous puberulous, 6- to 12-flowered, occasionally solitary in subterminal shoots ; pedicels slender, pinkish, minutely puberulous, later glabrous, the lowermost pedicel upto 3·8 cm. long. *Flower buds* globose, 8-16 mm. across, glabrous, bracts caducous. *Flowers* white, showy, about 3-4 cm. across, fragrant. *Sepals* four, concave, two seriate, imbricate, caducous glabrous, almost similar in size and shape, about 10 mm. long, 8-9 mm. broad. *Petals* four, white, caducous, spreading, puberulous on both surfaces, more so towards the base, the two pairs of petals almost similar or the outer two slightly larger, obovate (spathulate in bud) about 11 to 12 mm. long, 10-11 mm. broad, the inner petals 11 mm. long and 10 mm. broad, prominently veined ; veins reticulate, diverging from base, the median rib very prominent. *Stamens* 45-60, spreading from base of gynophore ; filaments slender, 2·5-3 cm. long, white, purplish on ageing ; anthers introse. *Pistil* on a slender gynophore, glabrous ; gynophore about 3·5-4·5 cm. long ; ovary ellipsoid or ovoid, about 3·5 mm. long, 2·5 mm. across, unilocular ; style obsolete ; stigma capitate ; ovules numerous on 3 or rarely 4 parietal placentae. *Fruit* baccate, indehiscent, 5-7 developing in a corymb, pendant at maturity, on a much thickened elongated stalk of the jointed peduncle and gynophore 8-10 cm. long, the gynophore cylindrical, never callose at its tip. Fruit globose, about 5-6 cm. across, apex prominently umbonate, greenish at first, turning orange-yellow at maturity, lustrous, purplish brown on drying ; pericarp thin, crustaceous ; endocarp pulpy, creamy or white. *Seeds* embedded in a pulpy viscous endocarp, reddish brown, 35-40, obovoid, about 1-1·2 cm. long, 1 cm. broad ; testa crustaceous ; embryo contorted ; cotyledons foliaceous, coiled, about 12 mm. long, 8 mm. broad, elliptic obtuse ; radicle stout. (Plate II, 2, and Plate III, C 2)

Habitat. This species grows on rocky slopes along dry deciduous forests usually associated with other species of *Capparis* and *Acacia.*

Flowering and fruiting. Flowers appear mostly from March to May and, sometimes, late flowering upto July ; fruiting period from May to September.

Specimens examined. Wight Herb., Kew Distr. no. 68, 1866-67, (CAL) loc. Pulicat and Nagari hills, near Madras (based on information from Kew, see discussion above under *C. cleghornii* Dunn) ; *Wight Herb-* presented in 1871, locality possibly lower Nilgiris (MH).

MADRAS STATE :

Coimbatore district : Anamalais, *Cleghorn* 1858 (CAL) ; Kolampalayam, *Fischer* 1846, 1862 (CAL) ; Mankara, *K. N. Subramanian* 235 (BSI) ; Thekkumalai, *Sebastine* 198 (MH) ; *Sundara Raghavan* 74349 (BSI).

Madura district: Lower Pulneys, *Rodriguez* 1833 (CAL) ; Vannathiparai, *Shetty* 10273 (MH).

Tirunelveli district. Kadayanallur, *Madras herb.* no. 15187 (MH).

ORISSA STATE :

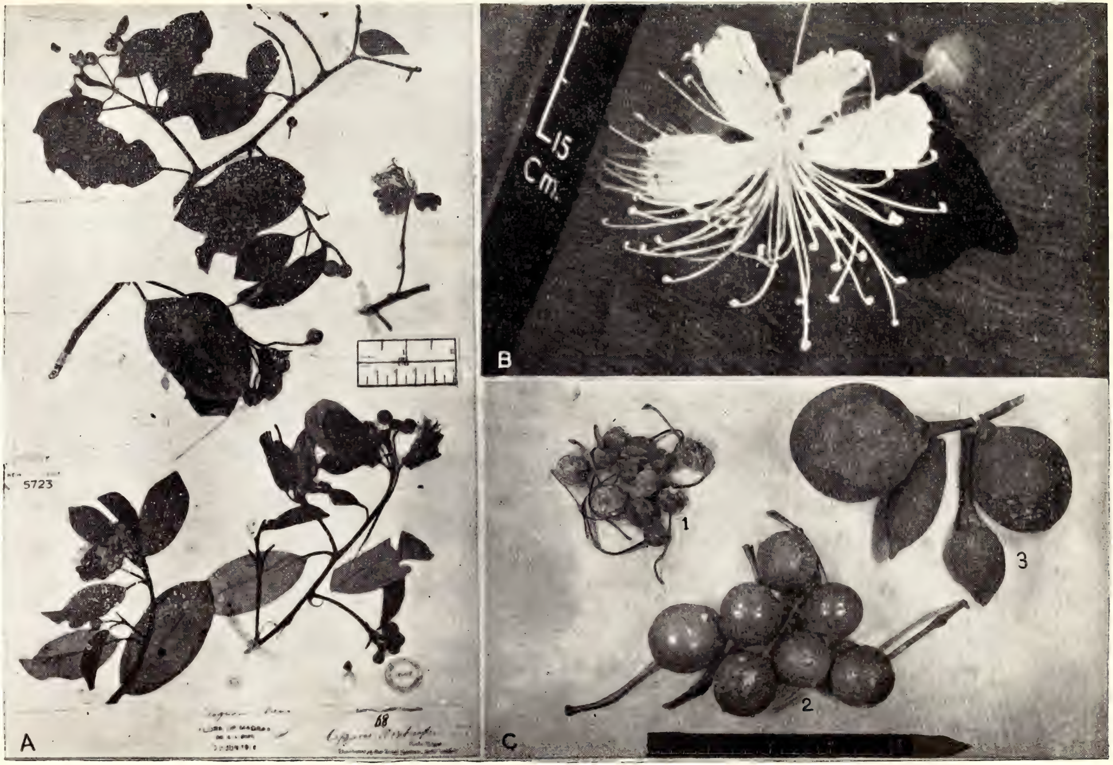
Ganjam district: Barkuda, *Annandale* 1332 (CAL) ; Baruni hills near Khurda, *Haines* 4070 (CAL) ; Chilka lake, *Prain s. n.* Cal. herb. no. 28751 (CAL) ; Rajabari islands, *Hooper* 39638 (CAL).

CEYLON :

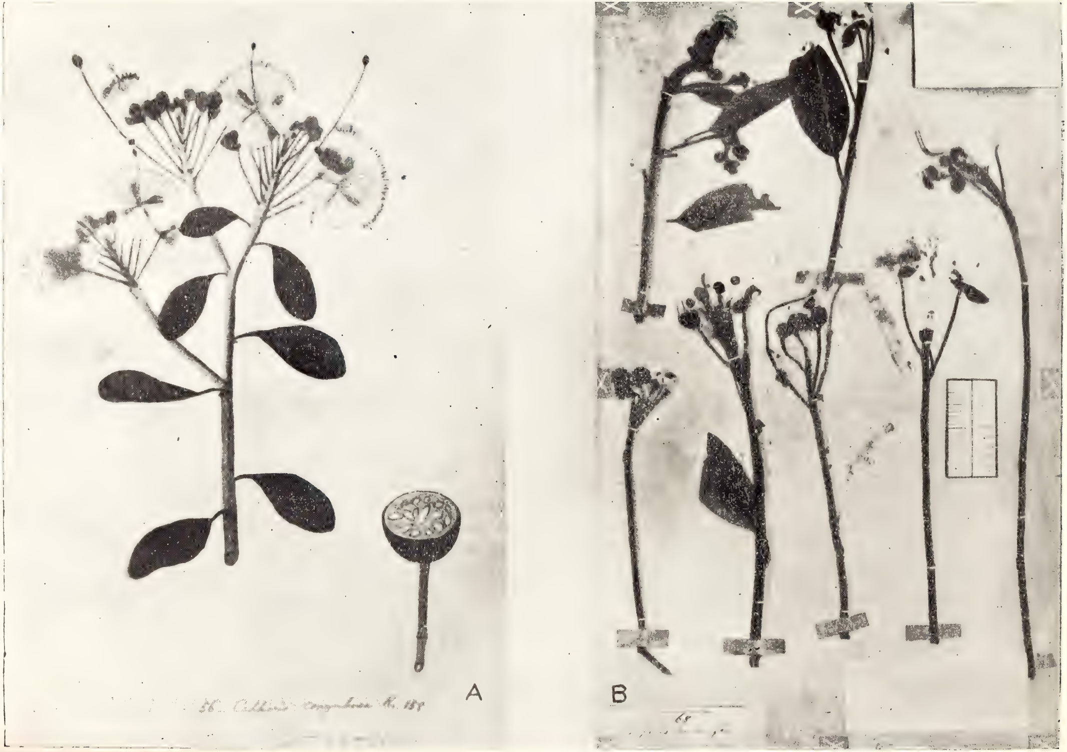
Thwaites s. n. Cal. herb. no. 28763 (CAL) ; *Thwaites* C. P. 1065 Cal. herb. no. 28764 (CAL) ; locality not known, *anon.* Cal. herb. no. 28765 (CAL).

Distribution. This species has a comparatively wider distribution but is mostly confined to the deciduous forests of south India along the lower Anamalais and Pulney Hills of Madras State, extending towards the north along the Eastern Ghat ranges of Andhra and Orissa States, and towards the south as far as Ceylon. It has so far not been collected in any of the high rainfall zones along the Western Ghats. The record of *C. roxburghii* DC. in the various floras by Graham, Dalzell & Gibson, and Nairne as occurring in the forests of western India is due to misidentification of *Capparis moonii* Wt. The description as given by Cooke in his FLORA OF BOMBAY under *C. roxburghii* DC. is possibly based on a mixture of two species, i.e. *C. moonii* Wt. and *C. cleghornii* Dunn.

Remarks. Roxburgh originally used the binomial *C. corymbosa* in HORT. BENG. and described it later in his FLORA INDICA. As *C. corymbosa* Roxb. was a later homonym for *C. corymbosa* Lamk., an African plant, De Candolle proposed the new name *C. roxburghii* in his PRODROMUS basing it on a specimen in the Banks Herbarium with the manuscript



A. *Capparis cleghornii* Dunn: Type sheet (Kew Negative 5723). Specimens on upper half labelled *Cleghorn* D 176 (designated as type); those on lower half marked *Kew Distr. No.* 68. (*Courtesy: Director, Royal Botanic Gardens, Kew*). B. *C. cleghornii* Dunn: Flower. C. Fruits of *Capparis* Linn: 1. *C. cleghornii* Dunn; 2. *C. roxburghii* DC.; 3. *C. moonii* Wt.



A *Capparis corymbosa* Roxb. from MS. of Roxburgh's ICONES, Plate No. 158 ; B. *Capparis roxburghii* DC.—Kew Distr. No. 68 (CAL) name of *C. aguba.* Incidentally ' aguba ' is also the vernacular name mentioned by Roxburgh under *C. corymbosa* in his FLORA INDICA. However, Dr. Jacobs (personal communication) could not locate in the Banks Herbarium, now in the British Museum, the sheet which constitutes the type. Since the specimen is not now traceable, Plate No. 158 in the Roxburgh ICONES under *C. corymbosa,* evidently drawn from the same material as *C. aguba* of the Banks Herbarium, is now designated as the type. Accordingly a photograph of the above plate from the set of Roxburgh ICONES in the Central National Herbarium, Calcutta, is now reproduced in this paper for the first time (Plate IV, A).

Capparis moonii Wt. Ill. 1 : 35, 1840 ; Hook. f. & Thoms. in Fl. Brit. Ind. 1 : 175, 1875 ; Trimen, Fl. Ceyl. 1 : 62, 1893 ; Cooke, Fl. Bomb. 1 : 46, 1903 ; Talbot, Forest Flora 1 : 59, 1909 ; Dunn in Gamble, Fl. Madras 1 : 44-45, 1915 ; Santapau, Fl. Khandala in Rec. Bot. Surv. India 16 : 10, 1953. *C. moonii* var. *tomentosa* Blatt. & Hallb. in Blatter, Jour. Bombay nat. Hist. Soc. 31 : 905, 1927 *ex char. C. roxburghii* auct., non DC. *excl. syn.* Graham, Cat. Bomb. Pl. 9, 1839 ; Dalzell & Gibson, Bombay Fl. 9, 1861 ; Nairne, Fl. Pl. W. India 18, 1894 ; Cooke, Fl. Bomb. 1 : 46-47, 1903 *pro parte.*

Woody climber ascending over 10 m. ; stem attaining a diameter of 15-20 (25) cm. at base, much branched ; young shoots flagellate, purplish, puberulous, glabrescent later, stipular spines few or even absent. older shoots glabrous, conspicuously spiny at base, spines stout, sharp, recurved. *Leaves* in fruiting specimens larger than in flowering shoots, 2·5-3 times as long as broad, 7-18 cm. long, 3-5·5 cm. broad, petiolate, petiole 1-1·5 cm. long ; lamina elliptic oblong, coriaceous, glabrous on both surfaces, lustrous adaxially, opaque abaxially, base rounded, apex with a twisted acumen, sometimes obtuse ; venation indistinct ; midrib distinct, channelled ventrally, ridged dorsally ; secondary ribs faint, 6-16 pairs. *Inflorescence* usually terminal, glabrous, 6- to 12-flowered, corymbiform, often solitary, axillary, pedicels stout, lowermost pedicel up to 5·5 cm. *Flower buds* globose 1-2·5 cm. across. *Flowers* bracteate, showy, 7-10 cm. across when in full bloom, white. *Sepals* four, two seriate, imbricate, caducous, hoary at first, later becoming glabrous, outer sepals slightly smaller than the inner, cup-shaped, about 15 mm. long, 12 mm. broad, the inner sepals about 18 mm. long, 16 mm. broad. *Petals* four, white, spreading, caducous, puberulous on both surfaces, outer two oblong, slightly narrowed about the middle, truncate and retuse at apex, about 3-3·5 cm. long, 2-2·5 cm. broad, the inner petals slightly smaller, narrowed at base, about 2·8-3 cm. long, 2·2-2·5 cm. broad, prominently veined, the veins spreading from base and dichotomously branched. *Stamens* numerous, approximately 150-170, spreading from base of gynophore, filaments slender, 5·5-7 cm. long, white to scarlet on ageing ; anthers basifixed, introse. *Pistil* on a slender gynophore, 6-8 cm. long ; ovary glabrous, ovoid about 5·5 mm. long, 3 mm. broad, green purplish tinged, unilocular ; style obsolete ; stigma sessile, capitate ; ovules numerous on 3 or occasionally 4 parietal placentae. *Fruits* baccate, indehiscent, mostly one to three developing in a corymb, apparently solitary, pendant from a conspicuous stout elongated stalk, the jointed peduncle and gynophore 12-16 cm. long, tip of the stalk usually callose ; fruits globose or subglobose, becoming narrowly cylindrical towards the base, about 13 cm. by 10 cm., apex rounded or umbonate, immature fruits similar in shape, occasionally ellipsoid, greenish at first, turning reddish brown at maturity ; pericarp at first thin, later becoming woody and much thickened ; endocarp viscous, pulpy, white or creamy at first, turning deep scarlet on exposure. *Seeds* embedded in the endocarp, reddish brown, 40-45, dorsally compressed, large, obovoid, about 1·6-1·8 cm. long, 1·2-1·5 cm. broad ; testa crustaceous ; embryo curled ; cotyledons foliaceous, curved and folded, about 20 cm. long, 10-12 mm. broad, ovate, acuminate ; radicle stout. (Plate II, 1 and Plate III, C 3).

Vern. names. *Wagati*, *Poorwi* (Marathi), *Luthikai* (Konkani).

Habitat. The species grows rather abundantly on laterite soil along rocky slopes mostly in the moist deciduous forests of the lower parts of the Western Ghats and also in the semi-evergreen forests along the upper slopes of the ghat region. The species has a good adaptability as to grow along rocky coastal areas including in a few islands off the west coast. It is normally bushy on exposed hillocks, but it assumes a scandent habit if proper support is available and ascends over 10 m. It is commonly associated with other species of *Capparis* such as *C. zeylanica* Linn. and *C. heyneana* Wall. besides other species like *Pittosporum floribundum* Wt. & Arn., *Terminalia crenulata* Roth, *Calycopteris floribunda* Lamk., *Cylista scariosa* Roxb., and *Carissa congesta* Wt.

Flowering and fruiting. Flowers appear usually from February to May but there is another short flowering period from October to December. Anthesis is mostly in the evenings, floral parts falling off the next day leaving the gynoecium. In N. Kanara district, along the coastal areas this species has two peak flowering seasons, once in October and the other in January-February. Fruiting material is to some extent available in December but is abundant from March onwards. At Khandala maximum frequency of flowering is in March-April and fruits persist till late July.

Uses. Talbot records that the leaves and bark are used in curries. Field observations and local inquiries do not support that the fruits are utilized as vegetable. Of late the fruits are reported to be efficaceous in the treatment of tuberculosis and skin ailments but investigations so far carried out on these aspects have yielded negative results only.

Specimens examined.

MAHARASHTRA STATE :

Poona district : Khandala-Lonawala, *Blatter* 18140, 27948 (BLAT) ; *Chibber s. n.* June, 1909 (BSI) ; *Cooke s. n.* Jan. 1892 (BSI) ; *Gammie* 16305 ; 16124 ; *s. n.*, Feb., 1891 ; *s. n.*, Feb., 1907 (BSI) ; *Merchant* 853 (BLAT) ; *Santapau* 41/5 ; 20 ; 23 ; 24 ; 1656 ; 3317 ; 3318 ; 8601 ; 10712 ; 10713 ; 12265 ; 15699 ; 18140 (BLAT) ; *Sundara Raghavan* 79648 ; 79649 ; 87101 (BSI).

Ratnagiri district : Malwan, *Santapau* 41/4 (BLAT) ; *anon. s. n.*, Blatt. Herb. no. 27560 (BLAT) ; *anon. s. n.* Cal. herb. no. 28744 (CAL).

MYSORE STATE :

Coorg district : Makut (?), *Arora* 32410 (BSI).

N. Kanara district : Amboli, *Gammie* 15049 (BSI) ; Ankola Ghats, *Talbot* 927 (BSI) ; Bhatkal, *Krishnamurthy s. n.* B.S.I. Herb., No. 62365 (BSI) ; *Sundara Raghavan* 74341 ; 79506 (BSI) ; Kumpta, *Anu Pharma s. n.* B.S.I. Herb. No. 36434 ; *Sundara Raghavan* 79408 ; 79447 ; 79458 (BSI).

GOA :

St. George Islands, *A. O. Hume s. n.* Cal. herb., no. 28742 (CAL).

KERALA STATE :

Kottayam district : Udumbanchola, *Meebold* 719/13112 (CAL) ; Anamalais, *Beddome* 37 (CAL).

Distribution. This species is widely distributed all along the western coast of India including some of the rocky islands near the shore and along the upper slopes of Western Ghats to 900 m. with an annual rainfall of 250 to 450 cm., covering the States of Maharashtra, Mysore, Goa, and Kerala. It further extends south to Ceylon. It has not so far been recorded from the crest of the Western Ghats or from the eastern slopes of the Western Ghats facing the Deccan plateau where *C. cleghornii* grows very well.

Remarks. From the extensive field observations, it is clear that *C. moonii* is the most common species along the Western Ghats especially in Maharashtra and N. Kanara district in Mysore State. The descriptions of ' *C. roxburghii* DC.' as given by Graham, Nairne, Dalzell & Gibson are all applicable to *C. moonii* only. Though Cooke records *C. moonii* separately in his FLORA OF BOMBAY PRESIDENCY, he mixes up the characters of *C. moonii* and *C. cleghornii* in his description of ' *C.*

roxburghii', confusing the young fruits of *C. moonii* with several seeds as belonging to '*C. roxburghii*', and this seems to be responsible for the record of *C. roxburghii* by Cooke in areas where mostly *C. moonii* and to some extent *C. cleghornii* only occur.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to Sir George Taylor, Director, Royal Botanic Gardens, Kew, for providing the type photograph of *Capparis cleghornii* Dunn and relevant data on Kew Distr. no. 68 ; to Dr. M. Jacobs, Rijksherbarium, for comments on *Capparis cleghornii* ; and to Prof. P. V. Bole, St. Xavier's College, Bombay, for facilities to work in the Blatter Herbarium.

SYNOPSIS

Considerable confusion exists regarding the botanical identity and treatment of the three closely related species *Capparis moonii* Wt., *C. roxburghii* DC., and *C. cleghornii* Dunn in the floras pertaining to peninsular India. Graham, Dalzell & Gibson, and Nairne seem to have confused *C. roxburghii* DC. with *C. moonii* Wt. Scrutiny of the specimens in Cooke's and Talbot's collections in the light of the description given by Cooke shows that Cooke based his description of '*C. roxburghii*' on a mixture of specimens of *C. moonii* Wt. and *C. cleghornii* Dunn. As regards *C. cleghornii* Dunn, the confusion is due to the original scanty description and to paucity of material, this species not having been collected again since the Cleghorn collections from Ballalrayandurga (Chikmagalur District, Mysore State) in 1846. Extensive field observations during the last two years and a scrutiny of herbarium specimens in the various Indian herbaria have established that these species are quite distinct with their distribution clearly marked out. *Capparis cleghornii* Dunn has been collected from the type locality and is known to be confined to the Western Ghats of Mysore State along the outskirts of evergreen forests. A detailed description of the three species with a key is given, and certain interesting observations on the type sheet studied at Kew are elaborated in this paper.

The nidification of some common Indian birds—Part 2

BY

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[*Continued from Vol.* **60** (1): 133]

2. THE JUNGLE CROW (*Corvus macrorhynchos* WAGLER)[1]

Previous Work. Very little is known about the breeding habits of the Jungle Crow. Hume (1873 : 411-413) was perhaps the first ornithologist to collate the data available on the subject, but many interesting aspects were left untouched. Many workers have written on the subject since then (Butler 1875 ; Davidson & Wenden 1878 ; Cripps 1878 ; Scully 1879 ; Vidal 1880 ; Reid 1881 ; Swinhoe & Barnes 1885 ; Barnes 1886 ; Davidson 1882 ; Taylor 1887 ; Hume 1889 ; Munn 1894 ; Jesse 1902 ; Ferguson 1903-4 ; La Touche 1906 ; Dewar 1909, 1929 ; Whistler 1928 ; Baker & Inglis 1930 ; Inglis 1931-34 ; Ali & Abdulali 1937 ; Ali 1946, 1953 ; Baker 1917, 1922, 1932; Aitken 1947 ; Bates & Lowther 1952, to cite a few), but it is still far from exhausted.

Breeding season. The breeding season of the Jungle Crow differs in different parts of India. Hume (1873 : 411 ; 1889 : 4) writing about the breeding season of the Jungle Crow stated : ' March to May is, I consider, the normal breeding-season ; in the plains the majority lay in April, rarely later, and in the hills in May ; but in the plains a few birds lay also in February.' According to Whistler (1928 : 4) the various races of Jungle Crow throughout India agree for the most part in laying their eggs from March to May, but in the plains a few nests will be found with eggs as early as the middle of December. Baker (1932 : 7-9) writing on the subject stated : ' The Northern Indian race breeds during December and January in Bengal and I have myself taken eggs as early as the 27th November in Eastern Bengal. In Bihar a few birds breed as early as the second week in January, but over the rest of its range across India as far west as the United Provinces and as far south as the Central Provinces the normal breeding-season seems to be late March to early May, most eggs being laid in April before the 20th of that month. . . . The breeding season of the Jungle Crow throughout southern India seems to be March, April and May. Major C. E. Williams took for me a fine series of their eggs between 9th of March and 3rd of May ; Bourdillon and others took eggs from 27th February to 20th May in Travancore. Davidson and Miss Cockburn give April and May as the breeding months in the Nilgiris, though Darling took a clutch of six eggs at Ooty as early as the 12th of February. In the South of the Bombay Presidency most eggs are laid in April and March.' Ali (1946 : 5) on the other hand stated : ' The normal breeding season in Peninsular India is between December and March or April ; North of Ganges and in Assam and Burma it is usually later, between March and May.'

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[1] This section is based almost entirely on observations made when I was working with the Virus Research Centre, Poona.

In and around Vellore (N. Arcot, Madras) where the present study was made the breeding season in 1956 lasted from early March to early June. Most eggs were found in April-May and most young in May-June.

Mating. By the beginning of March small flocks of Jungle Crow which habitually feed in cultivated fields, scrub jungle, and often in and around villages in company with House Crows tend to disintegrate into pairs. Partners are sought out and courted. The pair keep fairly close together. The Jungle Crow, like the House Crow, appears to be rather discreet about the display of connubial affection and sexual intercourse. In spite of its being one of the common birds of India very few people observe the Jungle Crow copulating. Copulation usually takes place in trees, sometimes on house tops or on the ground, and occasionally in the middle of a road (Berriff 1927). The presence of others of the species while the copulation is in progress is ignored nonchalantly. The sexual union may or may not be preceded by a mild head-tickling. The copulation is done in the usual bird fashion, very much like that of the House Crow. No particular timings are observed for the act and the conjugation is very frequent when the nest is under construction.

Nest building. Unlike the House Crow, the Jungle Crow seems to be rather selective about the site of the nest. Normally a fork high up in a tall tree is selected on the outskirts of, or near, human habitation, in well-wooded open land, cultivation, or waste ground. In localities where tall trees are wanting or have already been occupied by others of the species smaller trees are made use of. It does not as a rule build its nest in buildings. Only once has a nest on the top of an old building been recorded (Baker 1932 : 8), but there too it built in a small bunch of *Ficus* growing on the roof. Usually, no other sites are selected, but I saw one nest of the Jungle Crow in the compound of the Institute of Veterinary Preventive Medicine, Ranipet, Madras, which was placed in a loop made of two insulated electric mains.

It is difficult to say which partner has the greater say in selecting the site, perhaps the female. But once the site is selected both partners take a keen interest in building the nest. Dry twigs and sticks are picked up from under the trees and hedges around the field and farm. If fallen sticks are not readily available, twigs from trees and sticks from fences and hedges are wrenched off. Wires are also occasionally made use of. Both the birds go hunting for building material but separately. The female appears to do the bulk of the construction work. The male takes part in actual construction to the extent of arranging the twigs he has brought. If the female happens to be at work on the nest when the male arrives with a twig, he prefers to pass it on to her and go away in search of more. The female may at times rearrange the stick the male has added in her absence. As the twigs are fairly thick she often finds it hard to adjust or bend a refractory stick and may take a few minutes to arrange it to her satisfaction. During construction the birds do not seem to be in much of a hurry. There are long intervals between spurts of building activity.

In the earlier stages of construction the nest has the appearance of a bunch of sticks put loosely in a fork their ends projecting in all directions. As more sticks are added and arranged it gradually acquires the shape of a somewhat rounded platform, loosely attached to one or both the limbs of the fork with intertwining twigs and sticks. Further sticks are added on the periphery and the sides, moulding it finally to a massive, broad, cup-shaped structure 35 to 45 cm. in diameter and 12 to 15 cm. deep, with walls 10 to 12 cm. thick. The inner cavity is lined with coconut fibre, grasses, grassroots, palm fibre and bark, and human, horse, or other animal hairs which are sometimes pulled off the backs of live animals or skins laid out for drying (Hutton 1848 : 9). The finished inner cavity is about 15 to 18 cm. across and 10 to 14 cm. deep. It usually takes a pair about seven to twelve days to construct a nest complete with lining.

Territory. There appear to be no territorial troubles. Others of the species are never attacked if and when they visit the nesting tree. Although highly gregarious otherwise, while breeding the Jungle Crow certainly appears to respect the privacy of others of the clan and two pairs will never be found nesting in the same tree. All other birds, as long as they are not birds of prey, are welcome to use the nesting tree in any way they think fit. Birds of prey are always chased and driven off. Other birds including the House Crow seem to be afraid of the Jungle Crow and do not normally dare to come near its nest. Once I saw a female koel resting in the shade of a large Banyan tree in which the nest of a Jungle Crow was located. One of the parents was sitting in the nest incubating and did not pay any attention to the koel.

Laying and clutch size. Egg-laying starts with the completion of the nest and sometimes even before the lining is complete. Three to five eggs are generally laid, at intervals of twenty-four to forty-eight hours (Table II).

TABLE II

LAYING PATTERN AND CLUTCH SIZE OF JUNGLE CROW (*Corvus macrorhynchos*)

Nest No.	1st egg laid on	2nd egg laid on	3rd egg laid on	4th egg laid on	5th egg laid on	Total No. laid
1	24/iv	25/iv	26/iv	28/iv	—	4
2	17/iv	18/iv	20/iv	—	—	3
3	17/iv	18/iv	19/iv	20/iv	—	4
4	28/iv	30/iv	1/v	2/v	—	4
5	27/iv	28/iv	29/iv	1/v	—	4
6	3/v	4/v	6/v	—	—	3
7	24/iv	25/iv	26/iv	27/iv	28/iv	5
8	8/v	9/v	10/ v	11/v	—	4
9	8/v	9/v	10/ v	11/v	—	4
10	27/iv	28/iv	29/iv	30/iv	1/v	5
11	27/iv	28/iv	29/iv	—	—	3
12	27/iv	28/iv	29/iv	30/iv	—	4

Occasionally six (Darling, cited by Hume 1889 : 7) and rarely two (Dewar 1909 : 238-39) are also laid. Baker (1932 : 8) is of the opinion that ' cases in which two eggs have been reported as incubated are probably incomplete clutches '. Recent researches, however, indicate that a number of environmental factors are responsible for the determination of clutch size in an indeterminate layer like this crow. It will not perhaps be entirely irrelevant to mention here some of the important factors in brief, although they have not been directly observed in connection with the present work :

1. Availability of food in the breeding area :

This is perhaps the most important factor governing clutch size. Abundance of food in the locality appears to induce birds to lay bigger clutches than normal. In a rodent plague the clutch of birds living on them may be double the usual figure or even greater, a phenomenon recorded from the arctic, temperate, and tropical regions (Schneider 1928 ; Elton 1942 ; Moreau 1944). Even the quality of the food available sometimes affects clutch size (Kluijver 1933, cited by Lack 1947a).

2. Climatic conditions :

Climatic conditions varying annually appear to influence the clutch size (Jourdain & Witherby 1918 ; Lack 1947b ; Parkhurst & Lack 1946 ; Walkinshaw 1944). Even a change of season may affect clutch size in double brooders (Stresemann 1928 ; Kendeigh 1941 ; Lack 1947a).

3. The age of the bird :

First year birds lay smaller clutches than older individuals (Ruiter 1941 ; Kluijver 1933 ; Wissel 1927). Very old individuals also tend to have reduced clutches (Jourdain 1925).

4. Individual peculiarities :

Sometimes it is observed that an individual bird which laid an unusually large or an unusually small clutch on one occasion tends to do the same on other occasions (Lack 1947a).

Regarding the determination of the average clutch size, Lack (1947a : 315-319) writes : ' I believe that, in nidicolous species, the average clutch size is ultimately determined by the average maximum number of young which the parents can successfully raise in the region and at the season in question.' He further states : ' The limitation of clutch size must be regarded not as a negative, the inability to produce more eggs, but as a positive act, the cessation of laying '. He also suggests that, in indeterminate layers, laying presumably ceases in response to either visual or tactile stimuli from the nest.

The eggs are broad ovals somewhat compressed towards one end. The shell is compact, fine, and slightly glossy. The ground colour is usually bluish green, olive-green, sometimes almost blue (Baker 1932 : 8), or olive or stone colour (Dewar 1929 : 26). They are blotched, streaked, smeared, freckled with brown or pale faded purple. The size, shape, ground colour, and the design, intensity, and shade of the markings varies a good deal in eggs from different clutches and, sometimes, in the various eggs of the same clutch. The average of thirty-seven eggs measured was 30.3 × 42.1 mm.

The Jungle Crow does not appear to be suspicious of or bear any malice towards the Koel (*Eudynamis scolopaceus*). I did not come across a koel's egg in any of the nests, possibly because extremely few nests of this species with eggs are left till June, when the majority of the koel eggs were met with in House Crows' nests. Instances are, however, on record (Ali & Abdulali 1937 : 91 ; Jerdon 1877 : 296) of koel parasitising the brood of this species.

Incubation. The female starts sitting as soon as the first egg is laid in the nest. Incubation for the most part is done by the female. The male relieves her at intervals. The birds are very close sitters and leave the nest unattended only in the hottest part of the day, when one or both the birds mount guard on the nest sitting in a shady spot near-by. Unlike the House Crow the bird sitting in the nest does not abandon the nest as soon as someone starts climbing the nesting tree. The incubating bird keeps sitting in the nest till the climber is very close. After leaving the nest they make menacing threats of attacking the human intruder but seldom strike. The Jungle Crow does not appear to take much notice of a slight change in the appearance of the contents of the nest. I have painted its eggs scarlet with transparent water colours by ones and twos in a clutch in several cases, and in one case all the five, without affecting the composure of the owners in the least. They neither deserted the nest nor made any attempt to destroy or get rid of the painted eggs. They devoured a Paddy Bird (*Ardeola grayii*) egg placed in an empty nest, but accepted and incubated one when substituted for one of their own in a clutch of four.

Period of incubation. In nine cases out of twelve the first fledgling hatched out after eighteen days of the laying of the first egg, in one case in seventeen, and in another in nineteen days (Table III).

TABLE III

PERIOD OF INCUBATION OF JUNGLE CROW (*Corvus macrorhynchos*)

Nest No.	1st egg laid on	1st fledgling hatched on	Period of incubation in days
1	24/iv	12/v	18
2	17/iv	5/v	18
3	17/iv	5/v	18
4	28/iv	16/v	18
5	27/iv	16/v	19
6	3/v	21/v	18
7	24/iv	12/v	18
8	8/v	26/v	18
9	8/v	25/v	17
10	27/iv	15/5	18
11	27/iv	did not hatch	
12	29/iv	17/v	18

One clutch that did not hatch out was incubated for twenty-nine days before it was finally deserted.

The young in the nest. The young hatch out one after the other, at intervals of twenty-four to forty-eight hours. The newly hatched young are entirely devoid of nestling down. They are unable to stand up and lie helplessly on their delicate and almost transparent abdomens. The body is light flesh-coloured. The eyes are closed. Beak and claws are soft and fleshy, and are of the same colour as the rest of the body. The neossoptiles make their first appearance some time between forty-eight to seventy-two hours after hatching. They consist of prepennae and are duly replaced by regular contour feathers (teleoptiles). The remiges and rectrices appear in the second week in the form of gramophone-needle-like structures at first, and then at the needle points appear tufts of hair-like feathers (barbs). At this stage, with elongated stem and tufts of hair at the distal end, they resemble miniature artists' brushes arranged in rows of uneven sizes. The tuft gradually elongates into rachis and vane, while the stem ultimately forms the calamus. By the end of the fourth week the young are fully fledged. The colour of the fully fledged young is similar to that of the adult bird.

Both the parents feed the young. The young are unable to accept food till they are twenty-four to forty-eight hours old. In the earlier stages the food hunting trips of the parents are arranged in such a way that one or the other of them is always available to guard or warn the nestlings against predators and intruders.

All the young that hatch out do not live to leave the nest (Table IV). The majority of deaths occur in the first fortnight and mainly for want of food. Rarely is death due to a chance fall or some marauder's attack.

TABLE IV

NESTING SUCCESS

Nest No.	No. of eggs laid	Incubation period in days	Total hatch	Fledglings that survived
1	4	18	4	3
2	3	18	3	3
3	4	18	4	3
4	4	18	4	2
5	4	19	4	4
6	3	18	2	2
7	5	18	4	3
8	4	18	3	3
9	4	17	3	3
10	5	18	4	3
11	3	19	did not hatch	
12	4	18	3	2
Total	47		38	31 =66%

The parent birds usually cannot meet the full demand of a clutch of five and sometimes even four nestlings; unless of course there is an abundance of food in the locality. The parents seem to exercise no discrimination whatsoever in feeding them, and stuff the food in the gaping mouth of one of them, presumably the nearest, until the supply is exhausted or the one being fed refuses to swallow any more. This is repeated at every visit and the young which are not fed until their stronger brethren have received all they can take go to the wall in the struggle for existence in the nest. The dead are thrown out without the slightest concern on the part of the parents. The nestlings who survive remain in the nest for three to four weeks. A three- to four-week old nestling is fully fledged and can fly short distances, if forced to do so. Generally before leaving the nest they stay around in the branches of the nesting tree where they are fed by the parents. Even after leaving the nest they stick close to the parents, usually the mother, for a few weeks and follow her wherever she goes. As soon as she picks up a little bit of food the demand for it by the young starts. Generally the mother transfers the morsel to the young.

Nesting success. Nesting success in the Jungle Crow depends on a number of factors, the most important ones being the amount of food available for the young at nestling stage, fertility of the eggs laid, and interference by predators. In the present study a total of forty-seven eggs were laid in twelve nests. A total of thirty-one fledglings survived (Table IV). It roughly works out to sixty-six per-cent.

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On *Caulerpa fastigiata* Mont. var. *fastigiata* in India

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(*With* 21 *figures on two plates*)

INTRODUCTION

From the shores of Bombay City, Boergesen reported *Caulerpa fastigiata* Mont. var. *fastigiata.* It is being reported, now, for the first time from Gujarat, where its forma *minor* Web. v. Bosse, which is a new find for India, and its forma *delicatula* Thivy & Visal. forma nova also occur. A key and descriptions with reference to the only variety of *C. fastigiata* Mont., known to occur in India, and to the forms of this variety are given below.

KEY TO *Caulerpa fastigiata* Mont. var. *fastigiata* AND ITS FORMS

1. Plants up to 3 cm. high ; ultimate short branchlets distinctly arcuate..2
1. Plants 3-9 cm. high ; ultimate short branchlets not distinctly arcuate, 112-250 μ in diameter...............var. *fastigiata*
2. Plants 0·3-1·5 cm. high ; arcuate assimilators 220-300 μ in diameter at the upper end, thick, not highly arched ; stolons 266-392 μ in diameter.........................forma *minor*
2. Plants 3 cm. high ; arcuate assimilators 180-240 μ in diameter at the upper end, slender, highly arched ; stolons 168-252 μ in diameter....................................forma *delicatula*

Caulerpa fastigiata Mont. var. **fastigiata**

C. fastigiata Mont., Hist. Phys. de l'ile de Cuba, p. 19, t. 2, f. 3, 1838 ; Web. v. Bosse in Ann. J. bot. Buitenz. 15 : 262, 1898 & Siboga Expedit. 59a : 96, 1913 ; Boergesen in Dansk. Bot. Arkiv 1(4) : 118, f. 93, 1913 ; idem in J. Indian bot. Soc. 11(1) : 55, 1932, et in Danske Vidensk. Selskab. Biol. Med. 12(2) : 29, 1935 ; Okamura, Ic. Jap. Alg. 4 : 14, t. 154, ff. 9-13, 1916 ; Gilbert in Repr. Pap. Mich. Acad. Sci.

Arts, Lett. 27 : 9, 1942 ; Dawson in Pac. Sci. 8(4) : 392, f. 9g, 1954 ; Taylor in Univ. Michigan Stud. Sci. Ser. 21 : 136, t. 10, f. 12, 1960.

(Plate I, figs. 1-5 ; Plate II, figs. 10-13)

Plants 3-9 cm. high, forming mat-like colonies, filiform, with branched stolon bearing erect axes at intervals of 0·1-1·2 cm., green including stolon, at times chlorotic in the basal region ; stolon 215-400 μ diameter, with free tips up to 3 cm. long, with stratified wall 5·2-7·8 μ diameter, having numerous transverse trabeculae 1·5-4·0 μ thick and contorted in the centre of the stolon, with a few longitudinal trabeculae of 1·3 μ thickness, with round to pyriform starch grains of 2·0-5·0 μ diameter and to 7·8 μ long or rarely 10·4 μ long.

Primary erect axes branched to first or second degree and sometimes to 5th degree, cylindrical throughout, 112-275 μ diameter, often subclavate at tips, slightly thicker at basal region, with obtuse or sometimes faintly acute tips, with cell wall 1·5-3·0 μ diam., having numerous transverse trabeculae 0·75-2·5 μ thick, with a few longitudinal trabeculae 1·3 μ diam. with round to pyriform starch grains up to 5·2 μ diameter, and up to 6·0 μ long. Branching of erect axes spiral or dichotomous and in the upper part in addition opposite or subwhorled. Branchlets when short 2·5-4·0 mm. in length, when longer up to 6.0 cm., usually both kinds found intermixed from below upwards. Rhizoids near origin 45-144 μ diameter, with wall 5·2-7·8 μ thick, simple, dichotomous or alternately branched, tapering to about 27·0 μ diameter, and here with walls 2.6 μ thick, when short often ending in attaching discs 70-300 μ diameter, when longer (3-8 mm. in length) sometimes with bulbous tip of about 40 μ diameter.

Specimens examined. Gopnath, *Iyengar* 452, 24-8-61 ; *Rao* 519, 13-10-61 ; *Thivy* 568, 11-11-61, 1688, 23-4-62, 2800, 29-7-62.

Habitat. On the western shores of the Gulf of Cambay, the waters of which are turbid nearly all round the year, Gopnath is situated ; and it has a limestone reef which is about 4 km. long and 100 metres wide, very rugged and gradually sloping. The plant grows in the mid-littoral, on the borders of and inside tide-pools and on the sides of low tide streamlets. It attaches itself partly to smooth rock-surface and partly to sand etc., in the silt which, as is well known for the plant, it accumulates by means of its numerous and often densely branched rhizoids. At low tide, the plant is exposed to an extent, or fully immersed ; and at high tide it is at a depth of about 2 metres. At all times of the year the plants are covered, often closely, with *Cocconeis clandestina* Schmitz, the frustules of which are cemented to the surface of stolon and erect branches. In November the submerged plants of *C. fastigiata* var.

fastigiata were concealed by a brown cloud of the chain diatoms *Biddulphia pulchella* Gray and *B. levis* Ehrenberg.

The plants growing in deep silt reach a height of 9 cm., and are characterized by thin assimilators, distinctly dichotomous erect axes, and chlorotic, often rhizoidiferous, basal regions of the erect axes. Plants more superficially embedded attain a height of 5 cm., bear thicker assimilators than the former, and have chiefly alternate, opposite or subwhorled, rarely in part dichotomous branching of the erect system.

At Gopnath, the variety is at its best from the end of July to February, though present all round the year.

Geographical Distribution. Bermudas, Florida, West Indies, Honduras, Panama, Brazil, Japan (Ryukyu Is.), Friendly Is., Philippines, Indonesia, India.

Observations. The stolons are slightly thicker than the branches of the erect system. In transverse section of the stolon the trabeculae are curled and contorted in the middle, but fused central areas formed by the trabeculae are not present as are seen, at intervals, along the length of the stolons in *Caulerpa verticillata* J. Ag. However, fusions (Fig. 13) at points where a few trabeculae cross are seen. Usually the rhizoids arise on the stolon between the points from where the erect axes start. Rhizoids exhibit special wall thickening, up to 13·0 μ, at their points of origin. The wall of the stolon has 2-4 distinct layers and these in turn are finely stratified. Stolons have numerous starch grains. Rhizoids and their bulbous tips are at times densely filled with them. The attaching discs develop from clusters of short, coralloid processes on the bulbous tips of rhizoids. The actively growing tips of rhizoids are slightly distended and have a cap-shaped cover of mucilage (Fig. 12).

When assimilatory branches are subwhorled they are in groups of 3-4, rarely 5. The trabeculae are visible through the walls of stolon and erect system, especially in bleached specimens. When growth in the Indian plant is luxuriant, groups of small rhizoids are at times seen all along some of the assimilatory branches at intervals of 1·0-1·5 mm. from apex to base, while some other branches show a group of rhizoids at the apex only. Boergesen (1913) observes that assimilators may serve for vegetative propagation.

Discussion. From the West Indian plant our plant varies in the upper range in height, namely 9 cm. in our plant and 3 cm. in the other as given by Taylor (1960). The plant in Japan also reaches a height of 3 cm. according to Okamura (1916). Further the upper limits in diameter of the stolon and of the branches of the erect system in the Indian plant are nearly double those of the West Indian plant.

Caulerpa fastigiata Mont. var. **fastigiata** f. **minor** W. v. Bosse in Ann. J. bot., Buitenz. 15 : 363, t. 20, ff. 1-2, 1898 ; Boergesen in Danske Vidensk. Selskab. Biol. Med. 20(6) : 36, 1946. (Plate I, figs. 6 and 7, Plate II, figs. 14-16)

Plants 0·3-1·5 cm. in height with branched stolon and erect axes. Stolons terete, 266-392 μ diameter, with acute tips and stratified walls of 5·2-10·5 μ thickness, with numerous transverse trabeculae of 2·5-3·0 μ thickness and contorted in the middle of the stolon, with starch grains up to 7·8 μ long and more or less pyriform. Rhizoids 0·1-1·0 mm. long, 48-168 μ diameter, with terminal discs 100-480 μ diameter. Erect primary axes in diameter about 200-316 μ below, rather narrowed at point of insertion on stolon, with starch grains up to 7·8 μ long, with walls 2·6-5·2 μ thick, with branchlets alternate, opposite, or subwhorled. Branchlets arising on all sides of erect axes, when short about 1·0-2·5 mm. in length and arched-clavate to cylindrical with lower part of arch 140-192 μ diameter and upper 220-300 μ diameter, when longer up to 4 mm. long and subclavate to cylindrical with 156-240 μ diameter. Branchlets with walls 2·6-3·9 μ thick, with starch grains up to 7·8 μ long usually and rarely 13·0 μ long and having 2·6-5·2 μ diameter at broader end, with transverse trabeculae 1.2-2.0 μ thick and much contorted in the middle of the branchlets.

Specimens examined. Gopnath, *Thivy* 1694, 23-4-62.

Habitat. On vertical, smooth, rocky walls of streamlets, in the mid-littoral of the limestone reef ; at low tide they were found exposed just above the water level. They were attached to membranous polychaete worm cases, to a tough and wiry dendroid coelenterate, to *Amphiroa fragilissima* as also to shell particles.

Geographical Distribution. Brazil, Mauritius.

The figures given by Madame Weber van Bosse of f. *minor* have been of help in identification of the present plant.

Caulerpa fastigiata Mont. var. **fastigiata** f. **delicatula** Thivy & Visal form. nov. (Plate I, figs. 8 and 9 ; Plate II, figs. 17-21)

Plantulae 3 cm. altae, stolone repente ornatae ; stolon 168-252 μ diameter. Axis erectus, inclusa parte basali subverticillata 1-2 cm. longus, 120-204 μ diameter, crassior ad basin, parte terminali filiformi 1-2 cm. longa, diametri uniformis 120-170 μ. Grana amyloidea in stolone et rhizoideis amplissima 7·8-13·0 μ longa. Ramuli late arcuati, clavati, c. 1 mm. longi. Differt a f. *minor* Web. v. Bosse statura altiore, stolone tenuiore, et ramulis assimilatoriis altius arcuatis.

Typus positus in Herb. CS & MCRI ad Bhavnagar sub numero *Iyengar* 719, 1-12-1961.

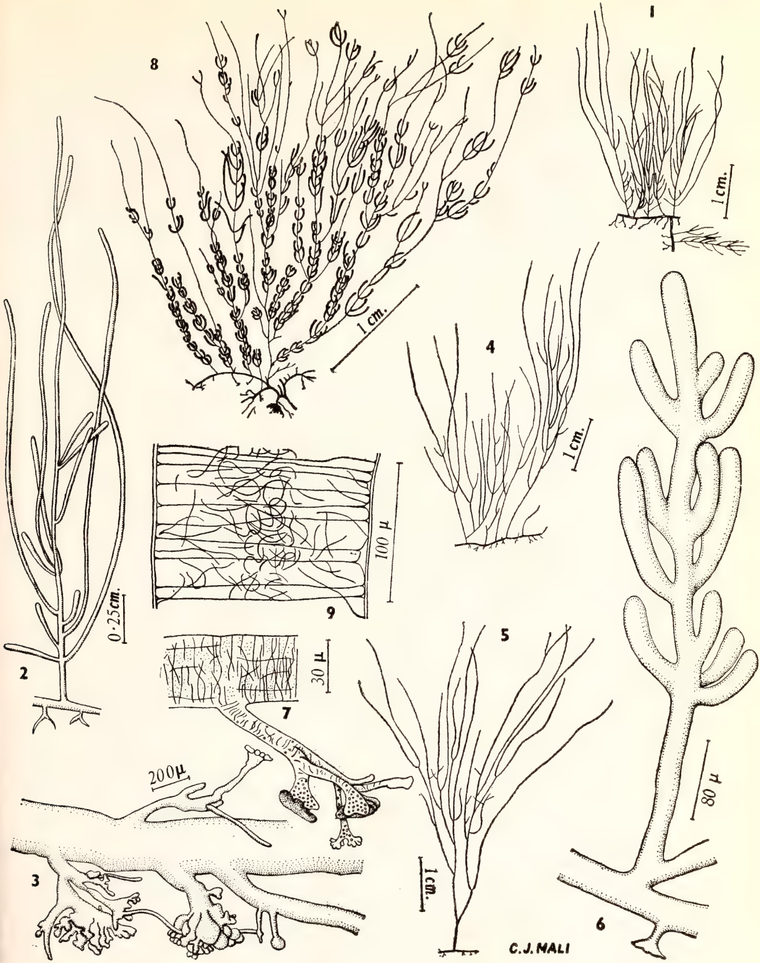
Plants reaching 3 cm. in height, with creeping branched stolon, and with erect axes. Stolon 168-252 μ diameter, with pointed tips and wall 2·6-5·2 μ thick usually, with transverse trabeculae 2 μ thick, these contorted in the middle, with starch grains often 7·8-13·0 μ long. Rhizoids reaching 7 mm. length, 70-120 μ diameter, with wall 2·5 μ thick, with starch grains often 7·8-13·0 μ long and 3·9-5·2 μ wide, with discs 216-240 μ diameter. Erect axes branched to second or third degree, slender, with lower part subverticillate and upper part filiform. Determinate branchlets on verticillate part short, about 1·0 mm. long usually, in part to 2 mm. long, clavate, arcuate, crowded, alternate, opposite or in subwhorled groups of 3 to 5, at the upper part of arch 180-240 μ diameter, at the lower part 120-180 μ diameter, with wall 2·5-3·2 μ thick, with thin transverse trabeculae and a few longitudinal trabeculae about 1·5 μ thick. Verticillate portion of erect axes 1-2 cm. in length, 120-180 μ diameter above, thicker below and 144-204 μ diameter. Filiform portion of erect axes 1-2 cm. in length, 120-170 μ diameter. Primary branchlets of filiform part of erect axes opposite, semiwhorled or alternate, 120-156 μ diameter, straight, cylindrical with wall 1.3-2.6 μ thick, 2 mm. or more in length. Starch grains in erect axes 5·2 μ long, commonly 7·8-13·0 μ long, with broader end 2·6-5·2 μ wide, slightly smaller in general than in the stolon and rhizoid.

Specimen examined. Okha, at Port Office reef, *Iyengar* 719, 1-12-1961.

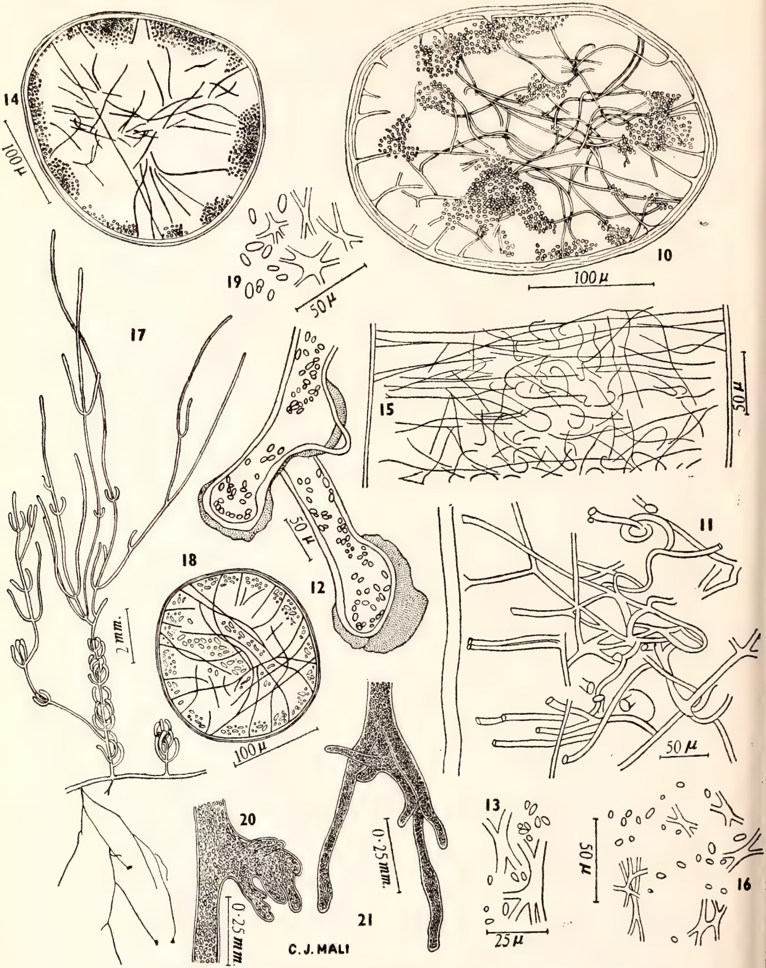
Habitat. In lower littoral, at low tide mark, growing on sand-covered limestone reef, with rhizoids attached to shell particles.

In general aspect the taller and more branched habit of the new form contrasts with the shorter, less branched plant, f. *minor* (3·0 cm. against 1·5 cm.) ; on the other hand the upper limit in diameter with reference to the stolon, the erect axes and the branchlets are less in the taller form, namely f. *delicatula*, than in f. *minor* (250 μ against 400 μ diameter in the case of stolon ; and 240 μ against 300 μ diameter in the case of erect axes and branchlets). The trabeculae in the determinate branchlets of f. *delicatula* are about 1·5 μ thick against 2·0 μ thick in those of f. *minor*. The starch grains in the stolon and rhizoids of f. *delicatula* are distinctly longer than in those of f. *minor*, being commonly 10·4-13·0 μ long in the former and not often longer than 7·8 μ in the latter.

In var. *fastigiata* and both its forms, starch grains are often densely packed in the stolon and rhizoids. By and large the trabeculae of the stolon and erect system are transverse in the three taxa and more or less contorted in the middle of the axes, where fusion between pairs of, or a few, trabeculae occur. A few, very fine, longitudinal trabeculae are seen in all three taxa.



Caulerpa fastigiata var. *fastigiata* from Gopnath : Figs. 1 and 2. Shorter plants (4·5 cm. high) showing stolon and erect system ; Fig. 3. Stolon with rhizoids terminating in coralloid discs, of shorter plant ; Figs. 4 and 5. Taller plant (9 cm. high) : Fig. 4. Showing portion with alternate and opposite branches ; Fig. 5. Showing portion of same plant with chiefly dichotomous branching. *Caulerpa fastigiata* var. *fastigiata* f. *minor* from Gopnath : Fig. 6. Stolon with an attaching disc and an erect axis bearing subwhorled determinate branchlets ; Fig. 7. Stolon showing trabeculae, and rhizoid ending in discs. *Caulerpa fastigiata* var. *fastigiata* f. *delicatula* from Okha ; Fig. 8. Habit showing stolon with rhizoids, a large and several small attaching discs, erect axes with subverticillate lower part and filiform upper part ; Fig. 9. Surface view of determinate branchlet showing transverse trabeculae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21
0·25 mm.
13
25μ
50μ
16
C. J. MALI

Caulerpa fastigiata Mont. var. *fastigiata*

For explanations see opp. page

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SUMMARY

Caulerpa fastigiata Mont. var. *fastigiata* known from Bombay is reported for the first time from Gujarat State, while forma *minor* Web. v. Bosse of this variety is a new report for India, and forma *delicatula* Thivy & Visal. of the same variety is a new form.

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Explanation to Plate II

Caulerpa fastigiata var. *fastigiata* from Gopnath. Fig. 10. T. S. of stolon showing stratified wall, trabeculae and starch grains; Fig. 11. Lengthwise half of stolon in surface view showing wall and trabeculae; Fig. 12. Tips of two rhizoids showing mucilage caps, cell wall, and starch grains; Fig. 13. Two trabecular fusions and some starch grains from T. S. of stolon. Figs. 14-16. *Caulerpa fastigiata* var. *fastigiata* f. *minor* from Gopnath: Fig. 14. T. S. of stolon showing stratified cell wall, trabeculae, and starch grains; Fig. 15. Surface view of arcuate determinate branchlet showing cell wall and trabeculae; Fig. 16. Starch grains, and fusions between trabeculae from T. S. of stolon. Figs. 17-21. *Caulerpa fastigiata* var. *fastigiata* f. *delicatula* from Okha: Fig. 17. Habit showing stolon, erect axes, rhizoids, arcuate determinate branchlets, and filiform branches; Fig. 18. T. S. of stolon showing stratified wall, trabeculae, and starch grains; Fig. 19. Starch grains, and fusions between trabeculae, from T. S. of stolon; Fig. 20. Rhizoid with a lateral disc formed of short branches; Fig. 21. Rhizoid with a terminal disc formed by a number of branches.

Fish Fauna of Muzaffarnagar District, Uttar Pradesh

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(*With a map*)

SYNOPSIS

A collection of eighty-four species of fish representing forty-nine genera, twenty families, and eight orders is reported together with brief notes on the maximum size, seasonal availability, breeding habits, etc. of each species. The report is based on two and a half years' work on the fish fauna of district Muzaffarnagar in the upper Gangetic plain. Analysis of the different species reveals that 75% of them belong to a single order, the Order Cypriniformes (Berg 1940), thirteen of them air-breathing and eight hill-stream species. Thus, the fish fauna is typical of sub-tropical fresh waters with a mixture of Himalayan forms. The richness of water resources and the possibility of the area developing into a big fish-producing centre is indicated. Distribution and nomenclature of some of the species is discussed in the light of the previous work and the present study.

INTRODUCTION

No attempt has so far been made to explore the fish fauna of Muzaffarnagar District in the upper Gangetic plain in spite of the richness of the water resources and a possible zoogeographical significance. Faunal studies covering much wider areas, such as those of Hamilton (1822) or Day (1878), are the only sources of information. More recently fish collections from three adjoining areas have been reported : from Eastern Doons (Hora & Mookerjee 1936 ; Lal & Chatterjee 1962), Meerut (Sinha & Shiromny 1953), and Delhi State (Majumdar 1958). In an earlier communication the author (Mahajan 1961) briefly reported a collection of sixty-two species belonging to seventeen different families based on one year's (1959-60) study of the fish fauna of Muzaffarnagar District. The present paper records a more exhaustive study of the same area carried out for more than two and a half years (July 1959-February

1962). In all, eighty-four different species were collected representing forty-nine genera and twenty families as compared with sixty species reported by Sinha & Shiromny (loc. cit.) from Meerut and sixty-two by Majumdar (loc. cit.) from Delhi State.

Material and Methods

The fishes were obtained with the help of fishermen. Cast net was most commonly used although sweeping, towing, and bag nets were also frequently employed. Visits to the Muzaffarnagar fish market were made almost daily during this period (July 1959-February 1962) while collections at the fishing sites were done once every week. Brief notes on the nature and size of catch were made at the spot. Representative specimens of each species were brought to the laboratory. Coloration and any other feature of special interest was recorded from the fresh fish. This was followed by detailed taxonomic examination either in fresh or preserved specimens as convenient.

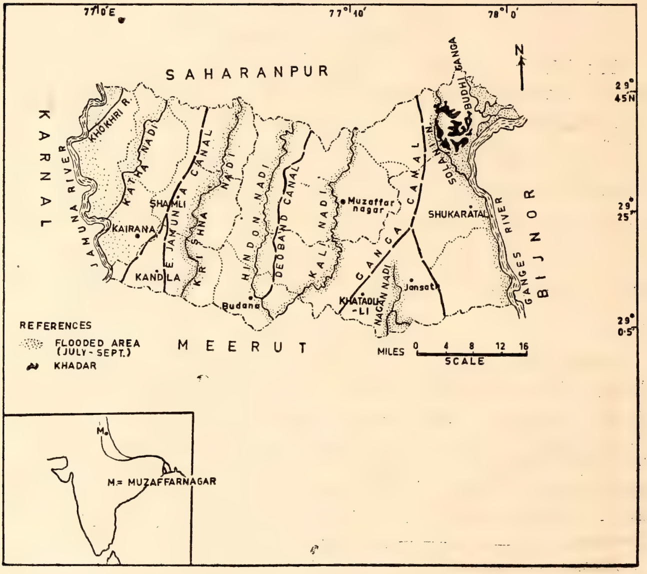
Physical Features

District Muzaffarnagar is situated in the doab of rivers Ganga and Jamuna, between districts Meerut in the south and Saharanpur on the north. On the west, River Jamuna separates it from Karnal District of Punjab, and on the east River Ganga forms the boundary separating it from Bijnor District. It is roughly rectangular in shape with an altitude varying from 256 metres to 238 metres above sea-level and lying between north latitude 29°11′30″–29°45′15″ and east longitude 77°3′5″–78°7′ covering an area of about 4300 sq. km.

~~There is a~~ considerable slope from north to south. This can be judged from the fact that within half a mile from the northern boundary of the district to within a short distance below the southern boundary no less than five falls are required on Ganges canal to moderate the otherwise *excessive slope* of the channel canal. This, coupled with the fact that the main rivers have just descended into the plains from the Himalayas, accounts for a number of hill-stream fishes recorded below.

Fishery Resources

The district has rich fishery resources (see map). Besides the two large rivers (Ganga and Jamuna) mentioned above, there are eight smaller ones which run through it from north to south. They are : Budi Ganga, Solani *nadi*, Nagan *nadi*, Kali *nadi*, Hindon *nadi*, Krishna *nadi*, Katha *nadi*, and Khokhar *nadi*. Moreover, there are four irrigation canals : Ganges canal, Anupshehr branch canal, Deoband branch canal, and East Jamuna canal. In addition to these ten rivers and four irrigation canals there are numerous perennial and seasonal ponds and lakes all over the district which are fed by local canal distributaries, flood, and rainwater drains. Nevill (1903) in the District Gazetteer estimates that approximately 327,310 acres of land was under water. The average rainfall varies from 84 cm. to 102 cm. in different parts of the district. This richness of water resources has resulted in a varied fish fauna fairly representative of the north Indian fresh waters.


77°10'E
77°40'
78°0'
SAHARANPUR
N
29° 45'N
29° 25'
29° 0.5'
KARNAL
JAMUNA RIVER
KHOKHRI R.
KATHA NADI
E. JAMUNA CANAL
SHAMLI
KAIRANA
KANDLA
KRISHNA NADI
HINDON NADI
DEOBAND CANAL
KALI NADI
Budana
Muzaffarnagar
GANGA CANAL
NAGAN NADI
KHATAULI
Jansath
SOLANI N.
BUDHI GANGA
SHUKARATAL
GANGES RIVER
BIJNOR
REFERENCES
FLOODED AREA (JULY-SEPT.)
KHADAR
MEERUT
MILES 0 4 8 12 16
SCALE
M.
M= MUZAFFARNAGAR

The Fish Fauna

The detailed list of the fishes collected during the period is given below. The classification is after Berg (1940). Local names are given wherever available. Information about the maximum size observed, habitat, seasonal availability, breeding habits, or any other peculiarity noted during the course of the work is also recorded briefly.

Discussion

An analysis of the fishes listed shows that 75% of the species belong to a single order, viz. Cypriniformes. About thirteen species are known to have varying degrees of air-breathing capacity. Of these, ten have remarkable accessory respiratory organs and one (*Amphipnous cuchia*) is in the words of Das (1940) the ' most highly evolved air-breathing fish among the Indian teleosts'. It will also be observed that a number of genera, e.g. *Gagata*, *Glyptothorax*, and *Garra*, characteristic of hill streams are found here. The only possible explanation of their occurrence in considerable numbers, specially during winter and monsoon, is that they are swept along the current and find conditions at least tolerable for survival and growth. In this connection, the presence of an excessive slope as described in the physical features of this region assumes significance. Such genera as *Crossocheilus*, *Glossogobius*, *Noemacheilus*, and *Puntius*, characteristic of the upper reaches of rivers, are very well represented here. The fish fauna of the district may, therefore, be characterized as sub-tropical with a mixture of Himalayan forms.

The regular availability of *Clarias batrachus* (Linn.) from a number of ponds in the district throughout the year is interesting in view of the report by Sinha & Shiromny (1953) that the species has only a localized distribution ' being found only in few ponds at Garh-Mukteshwar in the months of April, May, and June '. It appears that *Clarias batrachus* is present throughout the year in these ponds, but these fishes are easily netted only in April, May, and June as most of the water dries up at that time and the level is the lowest. Netting from July onwards becomes increasingly difficult as the water level rises with the onset of rains. The fish finds a safe place in the bottom of the pond which is its natural habitat.

The distribution of *Mystus corsula* (Ham.) is reported (Day 1878) to be from ' Orissa through Bengal and Assam '. The only report of its occurrence in this region is by Sinha & Shiromny (1953) from Hindon *nadi* in Meerut District. Similarly *Sicamugil* (*Mugil*) *cascasia* (Hamilton) has been recorded by Day from ' rivers of N.W. Provinces and Assam '. The only report of the occurrence of this species in this region is from Jamuna River from Delhi State (Majumdar 1958).

Although Berg's classification (1940, 1955) has been followed, certain misspellings and changes in current generic names pointed out by Briggs (1961) and others have been duly taken note of and corrections made accordingly. For example, *Noemacheilus* (van Hasselt 1823), wrongly spelt as *Nemachilus* by Berg (1940, 1955) perhaps following Günther (1868); and *Channa* (Scopoli 1777, as pointed by Myers & Shapovalov 1931) instead of *Ophiocephalus* (Hamilton 1822) or *Ophicephalus* (Bloch 1793). Generic names *Rhinomugil* Gill and *Sicamugil* Fowler have been preferred following Pillay (1962). Briggs (1961) pointed out that *Synbranchus* (Bloch 1795) rather than *Symbranchus* (Müller 1841) is correct. If so, it would be reasonable to spell the order named after this genus Synbranchiformes instead of Symbranchiformes (Berg 1940).

For most of the fishes the breeding season is the monsoon (July-Sept.), but some species are known to breed much before the onset of the monsoon, as has been observed in *Mystus*, *Wallago*, *Channa*, and *Mastacembelus*.

The behaviour, courtship, spawning, migration, etc. of these fishes would be an interesting and important subject for further investigation.

At least 33% of the fishes listed are of considerable economic importance. A proper development of the fishery of the area can make it a great fish-producing centre, supplying fish to great consuming centres such as Calcutta and Delhi. Even at present all large-sized fish are sent to Calcutta. This aspect of the subject is proposed to be dealt in a separate paper.

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* References marked with asterisk have not been consulted in original and have been quoted from Briggs (1961).

TABLE

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
			Order CLUPEIFORMES	
			I. Family Clupeidae	
1	*Gadusia chapra* (Hamilton)	Khera	16 cm.	Riverine, available throughout the year in large numbers.
			II. Family Notopteridae	
2	*Notopterus chitala* (Hamilton)	Chital, Mor	1·2 m.	Mostly from Ganga and Jamuna
3	*Notopterus notopterus* (Pallas)	Phulai, Patra	45 cm.	Available from rivers, ponds, and lakes throughout the year in fairly good numbers. Sometimes marketed alive without water.
			Order CYPRINIFORMES	
			Division CYPRINI	
			III. Family Cyprinidae	
4	*Oxygaster bacaila* (Hamilton)	Chal, Chilwa	31 cm.	Riverine, available throughout the year in large numbers.
5	*Laubuca atpar* (Hamilton)	Piocha	10 cm.	Riverine, available throughout the year in large numbers.
6	*Barilius bola* (Hamilton)	Gulab	31 cm.	Riverine. A few specimens available occasionally. Fished in greater numbers during winter (December-February).

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
7	*Barilius barna* (Hamilton)	Popta	10 cm.	Rivers, ponds, and lakes. Rather uncommon.
8	*Barilius vagra* (Hamilton)			
9	*Barilius modestus* (Day)			
10	*Barilius blendensis* (Hamilton)	—	20 cm.	Mostly confined to Ganga.
11	*Barbus* (*Tor*) *tor* (Hamilton)	Mahseer, Tor	62 cm.	Mostly from Ganges or Hindon *nadi*.
12	*Puntius chagunio* (Hamilton)	Chhiban	45 cm.	Available from all the rivers throughout the year but more abundant during summer.
13	*Puntius sarana* (Hamilton)	Durai, Putha	30 cm.	The most common mahseer both from rivers and ponds.
14	*Puntius conchonius* (Hamilton)	Puthi	Generally of small size not exceeding 12·5 cm.	Available from ponds and rivers alike throughout the year but specially after monsoon (September-November).
15	*Puntius stigma* (Hamilton)			
16	*Puntius chrysopterus* (Hamilton)			
17	*Puntius punjabensis* (Day)			
18	*Puntius sophore* (Hamilton)			
19	*Puntius ticto* (Hamilton)			

20	*Aspidoparia morar* (Hamilton)	Moraki	18 cm.	Both from rivers and ponds. Occasionally available throughout the year.
21	*Crossocheilus latius punjabensis* Mukerji	Rori	20 cm.	Riverine. Occasionally available specially after rains and during winter.
22	*Amblypharyngodan mola* (Hamilton)	Mohil	10 cm.	Often fished both from ponds and rivers in fairly good numbers.
23	*Rohtee cotio* (Hamilton)	Gurda	10 cm.	Most abundant among the minor carps, fished throughout the year from rivers and ponds.
24	*Catla catla* (Hamilton)	Katla	180 cm.	Available from ponds and rivers. Used for pisciculture. Highly prized as food. Mostly sent to Calcutta.
25	*Esomus danricus* (Hamilton)	—	10 cm.	Only occasionally netted but found both in ponds and rivers.
26	*Cirrhina mrigala* (Hamilton)	Naini, Narain, or Mrigal	90 cm.	More frequently available than either Catla or Rohu both from ponds and rivers. Large-sized fish mostly sent to Calcutta. Weighs up to ten kg.
27	*Cirrhina reba* (Hamilton)	Raibata, Reba	31 cm.	One of the most frequently seen fish in the market. Available from both ponds and rivers in large numbers.
28	*Labeo rohita* (Hamilton)	Rohu	90 cm.	The most prized food fish both from ponds and rivers. Used for pisciculture. Big-sized fish are sent to Calcutta.
29	*Labeo calbasu* (Hamilton)	Kalbauns	45 cm.	The most common major carp in Muzaffarnagar market.
30	*Labeo gonius* (Hamilton)	Kursa	45 cm.	Generally available throughout the year from both ponds and rivers. Less during monsoon (July-September), more common from October to February.
31	*Labeo dero* (Hamilton)	Chilwa	15 cm.	Mostly riverine, frequently available.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
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8	*Barilius vagra* (Hamilton)			
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10	*Barilius blendensis* (Hamilton)	—	20 cm.	Mostly confined to Ganga.
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15	*Puntius stigma* (Hamilton)			
16	*Puntius chrysopterus* (Hamilton)			
17	*Puntius punjabensis* (Day)			
18	*Puntius sophore* (Hamilton)			
19	*Puntius ticto* (Hamilton)			
20	*Aspidoparia morar* (Hamilton)	Moraki	18 cm.	Both from rivers and ponds. Occasionally available throughout the year.
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23	*Rohtee cotio* (Hamilton)	Gurda	10 cm.	Most abundant among the minor carps, fished throughout the year from rivers and ponds.
24	*Catla catla* (Hamilton)	Katla	180 cm.	Available from ponds and rivers. Used for pisciculture. Highly prized as food. Mostly sent to Calcutta.
25	*Esomus danricus* (Hamilton)	—	10 cm.	Only occasionally netted but found both in ponds and rivers.
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31	*Labeo dero* (Hamilton)	Chilwa	15 cm.	Mostly riverine, frequently available.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
32	*Labeo pangusia* (Hamilton)	—	15 cm.	Both from rivers and ponds throughout the year in fairly good numbers.
33	*Labeo doycheilus* (Hamilton)	—	91 cm.	Fairly common throughout the year in both rivers and ponds.
34	*Garra gotyla* (Gray)	Pathar chat	15 cm.	A few specimens occasionally netted from Solani *nadi* and Kali *nadi*.
35	*Danio devario* (Hamilton)	—	10 cm.	Mainly from ponds.
			IV. Family Cobitidae	
36	*Noemacheilus corica* (Hamilton)	—	5 cm.	Mostly netted during rainy season along the Ganges and Jamuna in pools and puddles formed after floods.
37	*Noemacheilus botia* (Hamilton)	—	7·5 cm.	Same as *Noemacheilus corica* except that *Noemacheilus botia* is more widely distributed.
38	*Noemacheilus zonatus* (McClelland)	—	5 cm.	
39	*Noemacheilus montanus* (McClelland)	—	10 cm.	
40	*Botia lohachata* (Chaudhri)	Billi, Bagatia	15 cm.	Available from ponds and small rivers like Kali *nadi*, Solani *nadi*, etc. More common than any of the species of *Noemacheilus*.
41	*Lepidocephalichthys guntea* (Hamilton)	—	10 cm.	Very rarely netted.

		Division SILURI		
		V. Family Siluridae		
42	*Wallago attu* (Bloch & Schneider)	Mulley, Ilaichi	150 cm.	By far the most common cat-fish and economically one of the most important. Available from all rivers and many ponds of large size. Breeding starts towards the end of April. The fish becomes comparatively scarce during monsoon (July-September) but becomes plentiful in winter (November-March).
43	*Ompok bimaculatus* (Bloch)	Pabda	30 cm.	Mostly riverine commonly available throughout the year.
		VI. Family Bagridae		
44	*Mystus* (*Osteobergus*) *seenghala* (Sykes)	Seenghara	90 cm.	Next only to *Wallago attu* in its economic importance among cat-fishes and perhaps more prized as food. Less common during monsoon (July-September) but becomes increasingly abundant from October onward to April. Available from all rivers and big ponds. Breeding starts in March or April.
45	*Mystus* (*Mystus*) *cavasius* (Sykes)	Kevas	25 cm.	Mostly from rivers although some ponds may also harbour them. Commonly available throughout the year.
46	*Mystus* (*Mystus*) *vittatus* (Bloch)	Tengan	15 cm.	Very common from both ponds and rivers. Can be transported alive small distances (15 minutes to half an hour) without water.
47	*Mystus* (*Mystus*) *aor* (Hamilton)	Aor	75 cm.	Mostly riverine. Much less common than Seenghara.
48	*Mystus bleekeri* (Hamilton)	Tengan	15 cm.	Common in rivers and ponds.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
32	*Labeo pangusia* (Hamilton)	—	15 cm.	Both from rivers and ponds throughout the year in fairly good numbers.
33	*Labeo doycheilus* (Hamilton)	—	91 cm.	Fairly common throughout the year in both rivers and ponds.
34	*Garra gotyla* (Gray)	Pathar chat	15 cm.	A few specimens occasionally netted from Solani *nadi* and Kali *nadi*.
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38	*Noemacheilus zonatus* (McClelland)	—	5 cm.	
39	*Noemacheilus montanus* (McClelland)	—	10 cm.	
40	*Botia lohachata* (Chaudhri)	Billi, Bagatia	15 cm.	Available from ponds and small rivers like Kali *nadi*, Solani *nadi*, etc. More common than any of the species of *Noemacheilus*.
41	*Lepidocephalichthys guntea* (Hamilton)	—	10 cm.	Very rarely netted.

Division SILURI

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
			V. Family Siluridae	
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44	*Mystus* (*Osteobergus*) *seenghala* (Sykes)	Seenghara	90 cm.	Next only to *Wallago attu* in its economic importance among cat-fishes and perhaps more prized as food. Less common during monsoon (July-September) but becomes increasingly abundant from October onward to April. Available from all rivers and big ponds. Breeding starts in March or April.
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47	*Mystus* (*Mystus*) *aor* (Hamilton)	Aor	75 cm.	Mostly riverine. Much less common than Seenghara.
48	*Mystus bleekeri* (Hamilton)	Tengan	15 cm.	Common in rivers and ponds.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
49	*Mystus corsula* (Hamilton)	—	30 cm.	Only occasionally met with.
50	*Rita rita* (Hamilton)	Khagga	120 cm.	Mostly riverine. Very common during monsoon but suddenly disappears with the end of rains (beginning of October). From October to June only stray specimens up to 15 cm. in length are netted, but with the onset of monsoon specimens 30-120 cm. in length become suddenly abundant. These fish have a remarkable power of sustenance outside water and are frequently marketed alive (without water) although no special accessory respiratory organs are known to exist.
			VII. Family Chacidae	
51	*Chaca chaca* (Hamilton)	—	16·2 cm.	Only one specimen from Ganga.
			VIII. Family Schilbeidae	
52	*Eutropiichthys vacha* (Hamilton)	Charkhi, Bacha	35 cm.	Mostly riverine. Common throughout the year, but more so during winter. Excellent sport.
53	*Silonia silondia* (Hamilton)	Silond	170 cm.	Found only in Ganga, Jamuna, and Hindon *nadi* throughout the year. In Kali *nadi*, Solani *nadi*, and others only during monsoon.
54	*Clupisoma garua* (Hamilton)	Bachua	30 cm.	Mostly riverine, available throughout the year.

55	*Pseudotropius murius* (Hamilton)	Gachua	24 cm.	Riverine. Rather scarce.
56	*Pseudotropius goongwari* (Hamilton)			
57	*Pangasius pangasius* (Hamilton)	Pangas	125 cm.	Restricted to large rivers like Ganga and Jamuna. Occasionally ascends Hindon *nadi* and Kali *nadi* when water level is high. Large specimens generally sent to Calcutta.
58	*Ailia coila* (Hamilton)	Saptyan, Basmati	18 cm.	Riverine, available throughout the year in large numbers.
		IX. Family Saccobranchidae		
59	*Heteropneustes fossilis* (Bloch)	Singhi	31 cm.	Available throughout the year, mostly from ponds. Dreaded for its 'venomous' pectoral spines which are promptly removed by fishermen as soon as they catch them.
		X. Family Clariidae		
60	*Clarias batrachus* (Linnaeus)	Magur	45 cm.	From most of the big-sized ponds and lakes in the Muzaffarnagar district. Available practically throughout the year although difficult to net from July to October when the water level in the ponds rises considerably and they can escape the fishermen's nets.
		XI. Family Sisoridae		
61	*Bagarius bagarius* (Hamilton)	Gonch	182 cm.	Restricted to larger rivers (Ganga and Jamuna) for the main part of the year, but during monsoon it ascends to Kali *nadi*, Hindon *nadi*, and Krishna *nadi*.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
49	*Mystus corsula* (Hamilton)	—	30 cm.	Only occasionally met with.
50	*Rita rita* (Hamilton)	Khagga	120 cm.	Mostly riverine. Very common during monsoon but suddenly disappears with the end of rains (beginning of October). From October to June only stray specimens up to 15 cm. in length are netted, but with the onset of monsoon specimens 30-120 cm. in length become suddenly abundant. These fish have a remarkable power of sustenance outside water and are frequently marketed alive (without water) although no special accessory respiratory organs are known to exist.
	VII. Family Chacidae			
51	*Chaca chaca* (Hamilton)	—	16·2 cm.	Only one specimen from Ganga.
	VIII. Family Schilbeidae			
52	*Eutropiichthys vacha* (Hamilton)	Charkhi, Bacha	35 cm.	Mostly riverine. Common throughout the year, but more so during winter. Excellent sport.
53	*Silonia silondia* (Hamilton)	Silond	170 cm.	Found only in Ganga, Jamuna, and Hindon *nadi* throughout the year. In Kali *nadi*, Solani *nadi*, and others only during monsoon.
54	*Clupisoma garua* (Hamilton)	Bachua	30 cm.	Mostly riverine, available throughout the year.
55	*Pseudotropius murius* (Hamilton)	Gachua	24 cm.	Riverine. Rather scarce.
56	*Pseudotropius goongwari* (Hamilton)			
57	*Pangasius pangasius* (Hamilton)	Pangas	125 cm.	Restricted to large rivers like Ganga and Jamuna. Occasionally ascends Hindon *nadi* and Kali *nadi* when water level is high. Large specimens generally sent to Calcutta.
58	*Ailia coila* (Hamilton)	Saptyan, Basmati	18 cm.	Riverine, available throughout the year in large numbers.
	IX. Family Saccobranchidae			
59	*Heteropneustes fossilis* (Bloch)	Singhi	31 cm.	Available throughout the year, mostly from ponds. Dreaded for its 'venomous' pectoral spines which are promptly removed by fishermen as soon as they catch them.
	X. Family Clariidae			
60	*Clarias batrachus* (Linnaeus)	Magur	45 cm.	From most of the big-sized ponds and lakes in the Muzaffarnagar district. Available practically throughout the year although difficult to net from July to October when the water level in the ponds rises considerably and they can escape the fishermen's nets.
	XI. Family Sisoridae			
61	*Bagarius bagarius* (Hamilton)	Gonch	182 cm.	Restricted to larger rivers (Ganga and Jamuna) for the main part of the year, but during monsoon it ascends to Kali *nadi*, Hindon *nadi*, and Krishna *nadi*.

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
62	*Gagata cenia* (Hamilton)	Padna		All these species of *Gagata* are frequently available from all the rivers. They can be netted in hundreds during rainy season when they seem to be swept down with the current. Of these three species, *Gagata viridescens* is most frequent and attains up to 15 cm. in length, others do not exceed 10 cm.
63	*Gagata nangra* (Hamilton)			
64	*Gagata viridescens* (Hamilton)			
65	*Glyptothorax telchitta* (Hamilton)	Tilier	15 cm.	Occasionally netted, more frequently during rains or winter.
66	*Sisor rabdophorus* (Hamilton)	Chamla	18 cm.[1]	Rarely netted, although available throughout the year. Sluggish, bottom-living, and of no food value. Fishermen claim that a preparation from this fish provides a cure for eczema.
			XII. Family Amblycepidae	
67	*Amblyceps mangois* (Hamilton)	—	4·5 cm.	Only two specimens collected.
			Order OPHIOCEPHALIFORMES	
			XIII. Family Ophiocephalidae	
68	*Channa punctatus* (Bloch)	Sauli	30 cm.	The first three species (68-70) are available throughout the year mostly from ponds. Of these *C. striatus* and *C. punctatus* are much more common than *C. gachua*. *C. marulius*, on the other hand, is mostly riverine.
69	*Channa striatus* (Bloch)	Saul	90 cm.	
70	*Channa gachua* (Hamilton)	Sauli	30 cm.	
71	*Channa marulius* (Hamilton)	Guldar Saul	125 cm.	

		Order PERCIFORMES		
		XIV. Family Gobidae		
72	*Glossogobius giuris* (Hamilton)	Gulwa	20 cm.	Occasionally a few specimens netted from Kali *nadi*, Solani *nadi*, Krishna *nadi* and Ganga.
		XV. Family Centropomidae (Ambassidae)		
73	*Ambasis nama* (Hamilton)	Chandla	10 cm.	Both the species are occasionally available from ponds all over the district.
74	*Ambasis ranga* (Hamilton)			
		XVI. Family Anabantidae		
75	*Colisa fasciatus* (Bloch & Schneider)	Kharda	13 cm.	Available throughout the year from ponds and lakes. Good aquarium fish.
76	*Colisa lalius* (Cuvier & Valenciennes)	Kharda	5 cm.	Mostly from ponds in the district although much less common than *C. fasciatus*.
77	*Nandus nandus* (Hamilton)	Bhedal, Kuwai	18 cm.	Riverine. Frequently available from all the rivers.
		Order MUGILIFORMES		
		XVII. Family Mugilidae		
78	*Rhinomugil (Mugil) corsula* (Hamilton)	Tara, Andwari	38 cm.	Available mostly from rivers throughout the year, but peak period of supply is just after the monsoon (September-November). It becomes scarce in summer (April, May).
79	*Sicamugil (Mugil) cascasia* (Hamilton)	Khaksi	8 cm.	Riverine. Available only during monsoon (July to September) from Kali *nadi* and Solani *nadi*.

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[a] excluding the upper caudal filament

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
62	*Gagata cenia* (Hamilton)	Padna		All these species of *Gagata* are frequently available from all the rivers. They can be netted in hundreds during rainy season when they seem to be swept down with the current. Of these three species, *Gagata viridescens* is most frequent and attains up to 15 cm. in length, others do not exceed 10 cm.
63	*Gagata nangra* (Hamilton)			
64	*Gagata viridescens* (Hamilton)			
65	*Glyptothorax telchitta* (Hamilton)	Tilier	15 cm.	Occasionally netted, more frequently during rains or winter.
66	*Sisor rabdophorus* (Hamilton)	Chamla	18 cm.[1]	Rarely netted, although available throughout the year. Sluggish, bottom-living, and of no food value. Fishermen claim that a preparation from this fish provides a cure for eczema.
		XII. Family Amblycepidae		
67	*Amblyceps mangois* (Hamilton)	—	4·5 cm.	Only two specimens collected.
		Order Ophiocephaliformes		
		XIII. Family Ophiocephalidae		
68	*Channa punctatus* (Bloch)	Sauli	30 cm.	The first three species (68-70) are available throughout the year mostly from ponds. Of these *C. striatus* and *C. punctatus* are much more common than *C. gachua*. *C. marulius*, on the other hand, is mostly riverine.
69	*Channa striatus* (Bloch)	Saul	90 cm.	
70	*Channa gachua* (Hamilton)	Sauli	30 cm.	
71	*Channa marulius* (Hamilton)	Guldar Saul	125 cm.	
		Order Perciformes		
		XIV. Family Gobidae		
72	*Glossogobius giuris* (Hamilton)	Gulwa	20 cm.	Occasionally a few specimens netted from Kali *nadi*, Solani *nadi*, Krishna *nadi* and Ganga.
		XV. Family Centropomidae (Ambassidae)		
73	*Ambasis nama* (Hamilton)	Chandla	10 cm.	Both the species are occasionally available from ponds all over the district.
74	*Ambasis ranga* (Hamilton)			
		XVI. Family Anabantidae		
75	*Colisa fasciatus* (Bloch & Schneider)	Kharda	13 cm.	Available throughout the year from ponds and lakes. Good aquarium fish.
76	*Colisa lalius* (Cuvier & Valenciennes)	Kharda	5 cm.	Mostly from ponds in the district although much less common than *C. fasciatus*.
77	*Nandus nandus* (Hamilton)	Bhedal, Kuwai	18 cm.	Riverine. Frequently available from all the rivers.
		Order Mugiliformes		
		XVII. Family Mugilidae		
78	*Rhinomugil (Mugil) corsula* (Hamilton)	Tara, Andwari	38 cm.	Available mostly from rivers throughout the year, but peak period of supply is just after the monsoon (September-November). It becomes scarce in summer (April, May).
79	*Sicamugil (Mugil) cascasia* (Hamilton)	Khaksi	8 cm.	Riverine. Available only during monsoon (July to September) from Kali *nadi* and Solani *nadi*.

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[1] excluding the upper caudal filament

S. No.	Scientific name	Local name	Maximum size observed	Remarks (Habitat, seasonal availability, etc.)
		Order BELONIFORMES		
		XVIII. Family Belonidae		
80	*Xenentodon cancila* (Hamilton)	Suan, Kagla	30 cm.	Occasionally available from rivers including smaller ones.
		Order MASTACEMBELIFORMES		
		XIX. Family Mastacembelidae		
81	*Mastacembelus armatus* (Lacépède)	Bam	75 cm.	Available from ponds and is generally found living in burrows in the bottom of the pond. Less common in winter. Breeding starts in April-May.
82	*Mastacembelus pancalus* (Hamilton)	Guj	25 cm.	Much less common than *M. armatus* but habits and habitat are similar.
83	*Rhynchobdella aculeata* (Bloch)	Malga	45 cm.	Rather scarce as compared to the two species of *Mastacembelus* above. Habits and habitat similar but restricted to fewer ponds.
		Order SYMBRANCHIFORMES		
		XX. Family Amphipnoidae		
84	*Amphipnous cuchia* (Hamilton)	Andhla Sanp	60 cm.	Found in ponds and aestivates when they dry up. Even dreaded by fisherman as it is considered to be a snake (' Blind snake ' is the literal translation of the local name).

Some plant records from the erstwhile Central Provinces and Berar

BY

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INTRODUCTION

From the perusal of the available literature it appears quite clear that very little work has been done on the flora of the erstwhile Central Provinces and Berar.

The first reference in this connection appears to be that of Brandis (1874) and Graham (1911). Brandis (1874) wrote a flora of NW. and Central India and Graham (1911) prepared a list of wild plants found on the Nagpur and Telankheri farms. Hole (1904) also contributed some papers on the flora of Jubbulpore Forest Division. Witt (1908) and Haines (1912-14) also prepared partial lists of trees, shrubs and economic herbs found in the Forest Circles of Central Provinces and Berar.

More recently Tiwari (1954, 1955) reported a number of grasses from Madhya Pradesh. But he collected mostly in the south-east M.P., i.e. from Bastar, Chanda, and Mandla districts. Mirashi (1954, 1959) made contributions to our knowledge mostly about the hydrophytes of Nagpur and its neighbourhood. Hewetson (1951) has drawn our attention to the neglect of plant studies in the State. Work on the exploration of the plants of this region has been taken up very recently by the Botanical Survey of India (Sebastine & Balkrishnan 1963).

Since Hooker's (1872-97) monumental FLORA OF BRITISH INDIA provincial floras have been prepared for most of the States. It is only Madhya Pradesh which does not possess a flora of its own.

Central Provinces and Berar, now Madhya Pradesh, occupy almost a central position in the Indian Union, and show a mixture of plants from the adjoining States. It is here that the Sal and Teak forests meet. Through Chanda and south Bastar, the Madras plants make their appearance; from the east the Bihar and Orissa plants intrude into M.P., and the Bombay flora makes its appearance through Yeotmal and Buldana districts of Berar. Through Jubbulpore and Sagar the Uttar Pradesh flora commences.

The present territories (before re-organization of States) included in M.P. vary in altitude, rainfall, and soil but the similarities are greater than the differences, and the present State (excluding certain outlying parts) is a satisfactory botanical unit.

The author while on a botanical tour to the Central Provinces and Berar in January-February 1959, and again in September-November 1959, has collected about 2000 plants and noticed a number of plants from this area which are not mentioned in the above-mentioned works except where otherwise stated. A number of weeds which are naturalized and established in other parts of India are seen in this province also. These are marked with an asterisk (*).

The plants have been arranged according to Bentham & Hooker's system of classification and every attempt has been made to adjust the nomenclature of plants according to the latest findings on the subject.

All the plants mentioned in this paper have been deposited in the herbarium of the National Botanic Gardens, Lucknow.

After a very short description of the plant, which is helpful in the identification of the plant in the field, the locality, from which the plants were collected, is given. The numbers indicate the field book numbers attached to the specimens.

PLANT RECORDS

ANNONACEAE

Annona squamosa Linn.

Small tree. Naturalized. Loc.: Ravines near Narnala Fort (609·6 m.), Distt. Akola. B[1] 66358.

NYMPHAEACEAE

Nymphaea nouchali Burm. f. Syn. *N. pubescens* Willd.

Large aquatic herb with pink, bluish and pale yellow flowers. Loc.: Common in ditches and tanks about Ramtek (C.P.). BP[1] 57544. This plant has not been reported by Graham (1913) from this area, and it appears therefore that it has been introduced after that date.

MALVACEAE

***Malachra capitata** Linn.

A suffruticose herb with yellow flowers. It is not indigenous but getting naturalized. Loc.: Marshy places at Dharampeth, Nagpur and Sonegaon Aerodrome, Nagpur. BP 70925, 70479. Recently reported from this area by Mirashi (1959).

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[1] In noting the specimen numbers the abbreviations, 'B'=Balapure and 'BP'=Balapure and Party, have been used.

***Malvastrum coromandelianum** Garcke. Syn. *M. tricuspidatum* A. Gray

A herb with yellow flowers. Loc. : Achalpur Camp, Distt. Amravati (Berar). BP 57834.

OXALIDACEAE

Oxalis corniculata Linn.

A prostrate herb with yellow flowers. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). BP 57764.

CUCURBITACEAE

Corallocarpus epigæus C. B. Clarke

Tendril climber with tuberous roots, fruits scarlet in the middle, the base and beak green. Vern. *Mirchi-kand.* Loc. : On way to Narnala Fort, Distt. Akola (Berar). B 66407.

RUBIACEAE

Oldenlandia aspera DC.

A stout annual herb with pale blue flowers. Loc. : Narnala Fort (762 m.), Distt. Akola (Berar). B 66372.

COMPOSITAE

Acanthospermum hispidum DC.

A South American introduced herb with yellow flowers and spiny achenes. This plant has spread very rapidly far into the forests. Loc. : Wari forest (609·6 m.), Distt. Akola (Berar) ; Muktagiri, Distt. Amravati (Berar) ; also at Nagpur. BP 57680, 70926. This is the first record of this plant from this area. From Nagpur it has been reported recently by Mirashi (1959).

Ageratum conyzoides Linn.

Annual weed with pale blue flowers. Loc. : Ramtek (C.P.) ; Nagpur. BP 57494.

***Lagasca mollis** Cav.

An introduced central American herb with white flowers in a solitary head-like terminal leafy inflorescence. Loc. : Achalpur Camp, Distt. Amravati (Berar) ; Muktagiri, Distt. Amravati (Berar); Nagpur. Very common in all the above localities. BP 57834, 57391, 57670, 70408.

***Tridax procumbens** Linn.

A procumbent hispid perennial herb with yellow-white flowers in head on long peduncle. Native of South America. It has been now naturalized. Loc. : Ramtek (C.P.), Nagpur. BP 70917.

Vernonia divergens Edgew.

A tall handsome shrub reaching 1·2-1·5 m. with pink flowers. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). BP 57718.

Vernonia cinerea (Linn.) Less.

A herbaceous plant with pink or lilac flowers. The plant is a variable one. Loc. : Ramtek (C.P.), Nagpur. BP 57451, 57422.

Centratherum anthelminticum O. Kuntze. Syn. *Vernonia anthelmintica* Willd.

A large erect annual about 0·6-0·9 m. with purplish flowers in sub-corymbose head. Loc. : Near Narnala Fort (762 m.), Distt. Akola (Berar). B 66482.

Sclerocarpus africanus Jacq.

An erect annual herb with yellow flowers, ovate acute serrate, strigosely hairy leaves and beaked, ribbed fruit. Loc. : In black cotton soil, particularly near field-hedges. Village Pathardi, Distt. Akola (Berar). B 66162.

CAMPANULACEAE

Campanula canescens Wall.

A slender delicate herb with very small white flowers. Loc. : Muktagiri near Achalpur Camp, Distt. Amravati (Berar). B 57704.

Wahlenbergia gracilis DC.

An erect perennial herb with blue flowers on long peduncles and linear leaves. Loc. : Near Narnala Fort (762 m.), Distt. Akola (Berar). B 66471.

PLUMBAGINACEAE

Plumbago zeylanica Linn.

A rambling subscandent perennial herb with white flowers and conspicuously glandular persistent calyces, the leaves ovate, membranous. Loc. : On way to Narnala Fort (762 m.), Distt. Akola (Berar). Rocky places. B 66495.

CONVOLVULACEAE

***Quamoclit coccinea** Moench. Syn. *Ipomoea coccinea* Linn.

A weak slender twiner introduced from S. America. Naturalized. Loc. : Storky Point Forest, Nagpur. BP 57407.

SOLANACEAE

Withania somnifera Dunal.

An erect branching undershrub reaching 1·5 m. in height ; all parts minutely stellate tomentose. Leaves broadly ovate up to 10·2 cm. long and little less in breadth ; flowers in axillary fascicles. Berry globose, enclosed in enlarged calyx. Vern. *Asgandh.* Loc. : Village Pathardi, Distt. Akola (Berar). B 66359.

***Solanum seaforthianum** Andr.

A pretty, somewhat woody climber with bluish purple flowers, fruit a globose berry, glabrous and scarlet. Complete description of the plant is available in Bor & Raizada's book SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS, Bombay, 1954. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). Cultivated and naturalized. BP 57816.

SCROPHULARIACEAE

Bacopa monnieri (Linn.) Pennell. Syn. *Herpestis monniera* Benth.

A somewhat succulent creeping herb with blue flowers. Common in wet places. Vern. *Nira brahmi.* Loc. : Village Pathardi, Distt. Akola (Berar). BP 57609.

Verbascum chinense (Linn.) Santapau. Syn. *V. coromandelianum* (Vahl) Kuntze ; *Celsia coromandeliana* Vahl.

An erect grey-pubescent annual with yellow flowers. Loc. : Muktagiri, Distt. Amravati (Berar), and Nagpur. BP 57676, 57353.

Lindernia parviflora (Roxb.) Haines. Syn. *Ilysanthes parviflora* Benth.

Erect slender herb. Leaves ovate-lanceolate, 5-10 mm. with 3-5 nerves from the base. Flowers white, 5-6 mm. on slender pedicels. Loc. : Marble Rocks, Jubbulpore (C.P.). BP 57294.

Lindernia pyxidaria All. Syn. *Vandellia erecta* Benth.

A small erect glabrous herb 10·2-20·4 cm. high, much branched from the base with sessile 3-to 5-nerved elliptic, oblong or ovate leaves tapering towards the base, lower 1·2-2 cm. long. Flower 5-7 mm. long white on very slender axillary, sub-erect spreading or rarely deflexed pedicels. Loc. : Marble Rocks, Jubbulpore (C.P.). BP 57312.

*__Scoparia dulcis__ Linn.

A small branched annual herb attaining a height of 2·6-12·7 cm. ; flowers small whitish. Native of tropical America, now naturalized. Loc. : Marble Rocks, Jubbulpore (C.P.). BP 57317.

*__Mecardonia dianthera__ Pennel.

Small herb. Native of tropical America. Loc. : Marble Rocks, Jubbulpore (C.P.). Not recorded by Duthie. BP 57205.

PEDALIACEAE

*__Martynia annua__ Linn. Syn. *M. diandra* Glox.

An erect branched annual, 0·3-0·9 m. high, flowers conspicuous and rose-coloured. Fruit hard, woody and black, very curious looking with prominent hooks. Native of Mexico. Naturalized. Loc. : Marble Rocks, Jubbulpore (C.P.), Village Pathardi, Distt. Akola (Berar). BP 57614.

VERBENACEAE

*__Lantana camara__ Linn. var. **aculeata** (Linn.) Moldenke

A straggling shrub with numerous curved prickles on the branches and orange-coloured flowers. Native of tropical America and run wild. The plant is most troublesome, and measures for its destruction are often necessary though difficult. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). BP 57716, 57678.

*__Stachytarpheta indica__ Vahl

A tall annual herb with long slender spikes of blue flowers. Native of tropical America. Cultivated and getting naturalized. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). BP 57812.

Clerodendrum infortunatum Linn.

A shrub 0·9-2·5 m. high. Flowers white tinged with pink. Loc. : Chikalda (762 m.), Distt. Amravati (Berar). BP 57814.

LABIATAE

Colebrookia oppositifolia Sm.

A shrub 1·2-1·5 m. high with white flowers in paniculate spikes. This plant has been included by Witt (1908) in his list on the authority of

Brandis (1874). We found this plant quite common on the hills near Chikalda (762 m.), Distt. Amravati (Berar). BP 57714.

Ocimum americanum Linn. Syn. *O. canum* Sims.

An erect herbaceous annual with a characteristic aroma. Flowers small, white. Loc. : Jalgaon-Jamod, Distt. Buldana (Berar). B 66050.

*__Hyptis suaveolens__ Poit.

A tall rigid, sweet-smelling herb with 4-angled rough-haired stem. Flowers collected in heads in the axils of leaves small and blue in colour. Native of tropical America and West Indies, run wild in C.P. and Berar. Loc. : Ramtek (C.P.), Nagpur, Achalpur Camp, Distt. Amravati (Berar). BP 57479, 57424.

AMARANTHACEAE

*__Alternanthera pungens__ H.B.K. Nov. Gen. et Sp. ii, 206 (1817) ; *A. echinata* Sm. in Rees Cyclop. n. 10 XXXIX (1819)

A diffusely branched prostrate herb. Flowers small much compressed and chaffy. This plant comes from tropical America and is getting naturalized along roadsides and waste places in Berar. Loc. : Jalgaon-Jamod, Distt. Buldana (Berar) ; Raundala, Distt. Akola (Berar) ; Marble Rocks, Jubbulpore (additional locality for M.P.). B 66005, 66070, 70373.

*__Gomphrena celosioides__ Jacq.

A diffusely much-branched annual. The branches are at first prostrate and then ascending and terminating in characteristic, stout, white spikes. Native of central America. A recently introduced weed. Loc. : Chikalda (762 m.), Distt. Amravati (Berar) ; Nagpur. BP 57804, 70691.

Celosia argentea Linn.

An erect, glabrous, branched herbaceous annual. The flowers are pinkish at first and then becoming glistening white. Loc. : Village Pathardi, Distt. Akola (Berar). BP 57615.

CHENOPODIACEAE

Basella rubra Linn.

A glabrous succulent climbing herb with small white or red flowers in spikes, the peduncle often becoming thickened. Common in hedges of fields. Loc. : Village Pathardi, Distt. Akola (Berar). B 66119.

EUPHORBIACEAE

Acalypha indica Linn.

Annual erect herb about 0·3-0·7 m. high, flowers in numerous, lax, erect, elongate axillary spikes. Loc. : Achalpur Camp, Distt. Amravati (Berar). BP 57842.

Tragia involucrata Linn.

An evergreen climbing hispid herb with stinging bristles variable in foliage. Loc. : Nagpur, Ramtek (C.P.) and Village Pathardi, Distt. Akola (Berar). BP 57330, 57476, 66154.

***Jatropha gossypifolia** Linn.

A small dark-coloured shrub with soft wood and reddish flowers. Native of Brazil and now naturalized on roadsides and waste places. Loc. : Nagpur. B 70597.

PONTEDERIACEAE

***Eichhornia crassipes** Solms.

Native of Brazil. A beautiful aquatic herb with violet-blue flowers. Loc. : Lakes and ponds in Jubbulpore (M.P.).

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Reproductive Behaviour of the Indian Spike-tailed Paradise Fish, *Macropodus cupanus* (Cuv. & Val.)[1]

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(*With two plates and a text-figure*)

INTRODUCTION

This paper presents descriptive and quantitative data on the sexual behaviour of the Indian spike-tailed paradise fish, *Macropodus cupanus*, in laboratory aquaria. The life history and early development of *M. cupanus* has been described by Raj (1916), Norman (1936), Jones (1940), and Padmanabhan (1955). No detailed quantitative data are available, however, on the reproductive behaviour of this species.

M. cupanus is an anabantid fish occurring naturally along the Malabar and Coromandel coasts of south India. According to Hervey & Hems (1963), it also occurs in Ceylon, Malay peninsula, and Sumatra. It is a small fish, adults reaching a maximum length of about 6 cm. Males are slightly larger than females. They occur in all types of freshwater: tanks, lakes, ditches, and streams, even in slightly brackish water. Their most typical habitats are wet rice paddy-fields and village tanks or ponds. They are capable of living in foul waters which are deficient in oxygen. They frequent thick vegetation or hide under stones or in crevices along pond edges. They are perennial breeders and the males build 'bubble nests'. They are carnivorous feeders and are considered valuable mosquito larvivores (Jones 1940).

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MATERIALS AND METHODS

The fish used in this study were wild-trapped in south India and were obtained through a Calcutta tropical fish dealer. When brought to the laboratory most of them were immature, in the size range of 2 to 4 cm. The fishes were fed with dry powdered daphnia and dry ' TRADIS ' fish food twice a day and with live tubifex worms once a day. *Vallisnaria spiralis* (domestic variety) was planted in all the breeding tanks. The tanks were lighted with 25 watt electric bulbs from 9 a.m. to 5 p.m. Overhead lights were kept on during working hours. The water temperature of the tanks was kept between 75° F. and 85° F. Most of the tanks used for observing reproductive behaviour were of 2.5 gallon capacity (measuring $30\times20\times20$ cm.). Seven-gallon tanks ($46\times25\times25$ cm.) were used as general holding and maturing tanks. The tanks were cleaned twice a week. The fish compositions of the tanks were intentionally varied. Sometimes a mature male was first introduced in the tank and one or two mature females were added afterwards before or after completion of the nest by the male. Sometimes a single mature pair was introduced in the tank together.

Fifty matings have been observed, and precise data have been recorded on 44 of them. This includes data on total duration of mating time, total number of eggs, number and duration of enfoldings[1] (copulations), number of eggs released per enfolding, and interval between enfoldings for each mating. The 44 matings studied in detail included 2128 separate enfoldings.

RESULTS

In this discussion reproductive behaviour of the fish will be considered under 3 headings : Pre-mating, Mating, and Post-mating Behaviour.

PRE-MATING BEHAVIOUR

This period extends from the beginning of courtship display between male and female and ends just before enfolding occurs.

Nest building by the male

M. cupanus males, like all other bubble nest building anabantids, build a bubble nest at the water surface which consists of very small bubbles heaped together. In our laboratory tanks, most of the nests were built at one corner of the tank and in few cases included floating leaf blades. Nest building indicates physiological maturity of the male (Goodrich

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[1] The term ' enfolding ' is used rather than ' copulation ' for two reasons : (1) to agree with the terminology of Forselius (1957), and (2) because fertilization is external.

& Taylor 1934). The males usually take 1½ to 2 hours to build a nest of about 4 cm. diameter and maximum height of 1 cm. The mechanism of building a nest involved the fish taking air in its mouth from the water surface, mixing it with mucus to form a froth, and then blowing several small bubbles which adhere together. This process is repeated many times and gradually a nest takes shape. Nest building is hastened in the presence of a mature female, and also by increased water temperature (Forselius 1957). The nests observed in our laboratory tanks were much smaller than those observed by Jones (1940) and Padmanabhan (1955) in the paddy-fields, which measured about 8 cm. to 13 cm. in diameter and 4 cm. in height.

Male responses towards the female

After completing the nest the male makes short trips to different parts of the tank apparently looking for a female, and returns to the nest quickly. If the male does not find a female for a long time, he does not take care of the nest and the nest breaks down.

When a mature female is in the tank the male will swim towards her and will butt her on the abdomen and on the fins with his snout. He will then swim back to the nest. He may on occasions stop on the way and look back as if to see whether the female is following him. This behaviour has been described for the genus *Macropodus* in general by Forselius (1957), and has been called ' leading to nest ' movement of the male. At this time the male displays erected fins, especially the tail fin. If the female is receptive she will follow the male but if the female is not receptive she will ignore him. Under this circumstance the male becomes aggressive towards the female and will usually chase and bite her.

Males without any nest are to some extent indifferent to immature females but will follow, rub, and butt a receptive female on the abdomen with the snout.

During sexual excitement the body colour of the male turns slightly dark, eyes and pelvic fins become red to orange, and the black spot at the base of the tail fin disappears.

Female responses towards the male

An immature female is usually indifferent to males either with or without nest. An incompletely mature female may start courtship displays with a male with nest. A mature female, when meeting a male without a nest, behaves peculiarly—she waves her body and moves randomly away from the male (sometimes facing the glass of the aquarium). It appears to be an expression of behavioural uncertainty. When a receptive female meets a male with nest she suddenly assumes a dull dark colour, her eyes become dark, the spines of the pelvic fins become orange, and the black spot at the base of the tail fin disappears and turns white. All of these changes occur in approximately 10 seconds.

When both individuals are mature either sex can take the initiative for mating. Usually the sex whose reproductive 'tempo'[1] is higher takes the initiative to breed (Forselius 1957). If the female reproductive 'tempo' is higher than that of the male she will proceed to the male under the nest and start waving her body in a head-down posture at an oblique plane. The male then starts circling movements around her body. Occasionally the female may exhibit head-down posture and body-waving movement at a lower level of water. Sometimes the female may rise up to the water surface at a distance from the nest and, after taking air from the surface, swim directly under the nest in an arc and display head-down, body-waving posture under the nest.

If these displays occur outside the nest the male makes a few circling movements around the female and then swims to the nest. The female normally follows him. Now the sexes engage themselves in circling movements under the nest. They move side by side in two circles—the female in the inner circle and the male in the outer circle moving in the same direction. There may be side dashes between the circling pair but not as vigorous as would be expected in an aggressive encounter. All circling movements do not lead to enfolding. The female after initial circling may settle down on the gravel and remain quiet for 5 to 10 minutes. At this time the male swims over to her and rubs her on the abdomen with the snout and shortly returns back to the nest. After 5 to 10 minutes the female responds to one of these 'leading to nest' movements of the male and goes to the nest. The circling movements then start again.

MATING BEHAVIOUR

Before actual enfolding the male and the female move in circles in the same direction. Sometimes the male moves faster and this brings the female's head region to the middle of the male's body. The position is then appropriate for enfolding. Simultaneously the male bends his body in the mid-region, the female begins a partial rotation to a lateral position in the water, and the male slides around to the ventral side of the female. The anterior portion of the female including her vent is then enfolded by the male's body. At this time the male's head and tail fin may touch on the dorsal side of the female. The female then rotates further and is turned upside down (Plate I). The pair usually remain in that posture throughout the duration of the enfolding. Sometimes the female is kept flat on her side at the time of enfolding. The postures of enfolding are basically similar in many species of anabantids. They are

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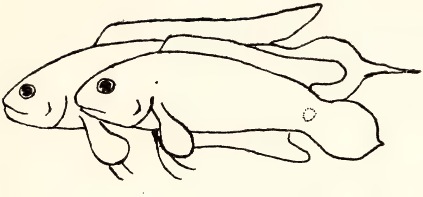
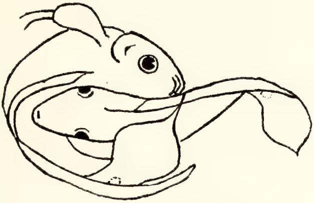
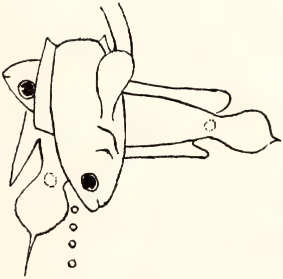
[1] 'Tempo' is a term used by Aronson (1949) in a way comparable to the psychological terms 'drive' or 'arousal'.



Circling
(male in background)

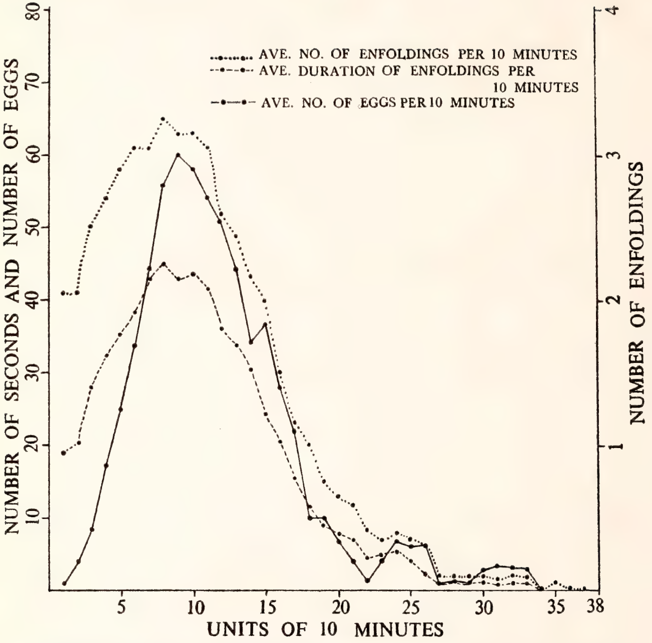


Beginning of enfolding
(female rotates on side, male folds around antero-ventral portion of female)



Enfolding and spawning
(female upside down, male arched dorsally over female as eggs emerge)

Mating postures in *Macropodus cupanus*



Mating pattern of *Macropodus cupanus* in terms of 10-minute units. Based upon averages of 44 matings.

Table

Reproductive Behaviour of *Macropodus cupanus*

Month	No. of observed matings	Mean no. of enfoldings per mating	Mean length of mating (Minutes)	Mean total no. of eggs	Mean total length of actual enfoldings (Seconds)	Av. no. of eggs per enfolding	Av. length of enfolding (Seconds)	Av. interval between enfoldings (Minutes)
November 1964	21	56·7 ± 3·7	195·2 ± 13·2	698·9 ± 30·4	750·0 ± 54·2	13·0 ± 0·8	13·1 ± 0·5	3·4 ± 0·2
December 1964	12	41·3 ± 3·3	151·7 ± 15·7	608·8 ± 44·0	538·9 ± 46·32	15·2 ± 1·1	13·3 ± 0·4	3·9 ± 0·02
January 1965	11	40·1 ± 2·6	140·0 ± 13·1	588·2 ± 34·10	463·8 ± 38·56	14·9 ± 0·8	11·5 ±0·5	3·2 ± 0·02
Total	44	48·4 ± 3·1	169·5 ±9·0	646·7 ± 21·6	620·9 ± 35·5	14·1 ± 0·5	12·8 ± 0·4	3·4 ± 0·01

accurately portrayed for *Macropodus opercularis* by Innes (1956) and for *Colisa lalia* by Forselius (1957) and these are very similar to *M. cupanus*. The duration of enfolding in *M. cupanus* varied from 5 to 22 sec. with an average of 12·8 seconds (Table). Enfoldings occurred at an average interval of 3·4 minutes.

Sometimes in the circling movement the female moves faster and the head region of the male is at the tail region of the female. Now, while the male continues to move, the female stops, so that the mid-body region of the male comes to the head region of the female and enfolding occurs as usual.

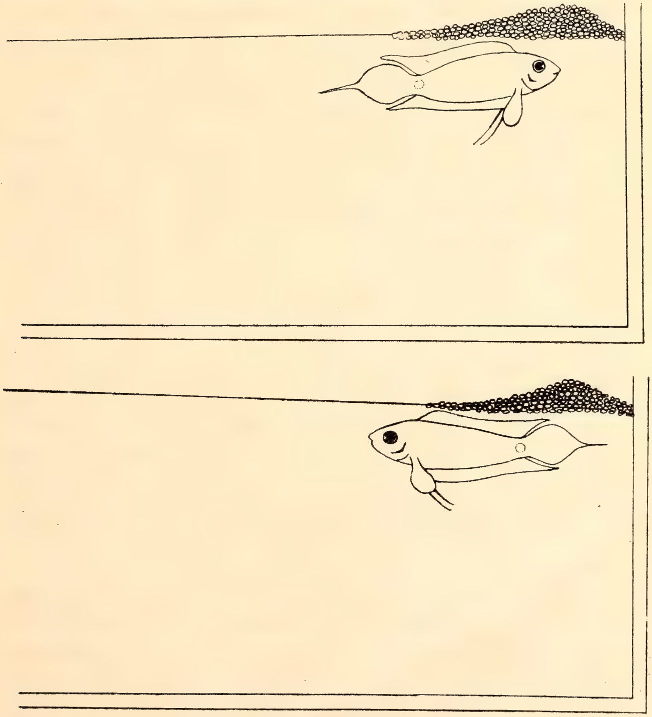
In the enfolded condition, there is no fin movement of the pair. The male's anal fin is curved inward and the female's body takes the form of a shallow ' S '. After a couple of seconds the grip of the male is slightly relaxed. The pair usually float in the enfolded condition but at the beginning of mating, in the first few enfoldings, they sink slowly downwards in the enfolded position. The eggs emerge from the cloaca at the anterior end of the base of the anal fin. The release of eggs and spermatozoa usually occurs within the first 6-8 seconds of enfolding. The number of enfoldings per mating varied from 26 to 102, with an average of 48·4 (Table). The duration of total mating was usually between 2 to 5 hours, and averaged 169·5 minutes. Spawning took place during day-time and more precisely between 11 a.m. to 3 p.m. In the first several enfoldings no eggs are extruded, then the number of eggs gradually increases reaching a maximum in the first half of the mating. Thereafter there is a gradual decrease in the number of eggs until no more are extruded (Plate II). An average of 14·1 eggs were extruded per enfolding with a total average of 646·7 eggs per mating (Table).

After extrusion, the eggs sink slowly in the water and both the parents pick them up into the mouth. The eggs are mixed with mucus and ' blown ' upwards into the bubble nest. The male is more active than the female in picking up the eggs. Usually the eggs at lower levels of water are picked up first and hence very few eggs drop to the bottom. When no more eggs are extruded, the pair still carry on enfolding for several times and then the male suddenly chases and drives the female out of the nest territory. The female does not leave the nest readily and on occasions a fight may occur between the pair. The female is always driven out of the nest territory, however, and she is chased into a corner of the tank away from the nest. By this time the female regains her normal colour. The female from time to time continues to swim up to the nest hesitantly, but is driven off by the male.

The Table at p. 467 indicates a seasonal influence upon the length and productivity of mating behaviour. There was reduced fecundity in December and January in comparison with November. Mating in November with a mean mid-morning temperature of 80·1° F. averaged

56·7 enfoldings per mating, an average mating time of 195·2 minutes, and a total average egg production of 698·9 eggs per mating. December and January, with mean mid-morning temperature of 75·5° F. and 75·8° F. respectively, showed reductions in the number of enfoldings per mating (to 41·3 and 40·1 respectively), the length of mating time (to 151·7 and 140 minutes respectively), and the egg production per mating (to 608·7 and 588·2 respectively). There were no significant monthly differences in the average eggs per enfolding, the average length of enfolding, and the average interval between enfoldings. The latter figures seem to be fairly constant (3·4, 3·9, 3·2) with a very small standard error for the over-all mean (3·38 ± 0·01).

Our data cannot determine whether these monthly changes in the length and productivity of mating are primarily due to temperature changes, day length changes, or some other factor.



Text-figure. Male in nest guarding postures

POST-MATING BEHAVIOUR

After driving the female away from the nest the male engages in protecting the nest and the brood. He adds new bubbles, re-arranges the eggs and chases off intruders. While guarding the nest, the male usually faces the corner of the tank and his tail may extend beyond the perimeter of the nest. At this time all the fins of the males are fully extended. Sometimes the male takes a reverse position under the nest, i.e. he faces outwards and his posterior end lies beneath the nest. The male increases the nest area by blowing more bubbles.

Hesitant intruders are immediately chased off by the male as in *Badis badis* (Barlow 1962). But when the intruders come to the nest without stopping the male becomes alarmed and blocks the intruders' way to the nest by placing his body in their path of movement. Then a fight occurs and the intruder is driven away. In every instance observed, the male was dominant in his own nest territory.

The embryos hatch approximately 32 hours after the eggs are laid. The newly hatched larvae cling to the nest in a vertical plane. Larvae which move out of the nest or drop from it are immediately picked up by the male in his mouth and put back to the nest. As the larvae grow older, they move about more freely and are picked up by the male as usual. When the young fry are 3 to 4 days old, they swim about rather freely, and at this stage they are usually eaten by the male, if he is not removed. Padmanabhan (1955) stated that males leave the nest in search of food when the larvae are 3 days old—this possibly occurs in natural conditions and not in laboratory aquaria. We have noticed that while guarding the nest the male takes no interest in the food supplied for 2 to 4 days after hatching.

DISCUSSION

Breeding Season

Thomas (1870) stated that *Macropodus cupanus* breeds during May and June. Jones (1940) collected eggs in January, February, May, September, October, and November and supposed that the fish may be perennial breeders. Padmanabhan (1955) also felt that *M. cupanus* breeds throughout the year. We are in accord with Jones and Padmanabhan and have observed mating in unheated aquaria throughout the winter months in Calcutta from October 1964 to March 1965.

Mating Behaviour

Courtship behaviour is an expression of the level of sexual excitability of the individual and it represents a co-ordination of behavioural activities and physiological processes of both sexes so that a well-synchronized spawning results. In general, the mating behaviour of *M. cupanus* is similar to that of *M. opercularis*, *Colisa* sp., *Trichogaster*, and several other anabantid fishes. The following discussion will consider some specific similarities and differences between *M. cupanus* and other fish.

At mating time most anabantids exhibit colour changes in both sexes. In *M. cupanus,* the males assume slightly dark colour and the females become completely dark including the eyes. Darkening of the eyes during sexual excitement is also seen in *Lebistes reticulatus* (Baerends, Brouwer, & Waterbolk 1955).

In the green sunfish, *Apomotis cyanellus,* the eyes turn black when the fish loses an aggressive encounter (Greenberg 1947). In the climbing perch, *Anabas testudineus,* males turn deep black during sexual excitement (Mookerjee & Mazumder 1946). In *M. opercularis* there is expansion of melanophores on the ventral and lateral sides in both sexes, and colours darken or become more intense (Forselius 1957).

Fishes of the genera *Colisa, Betta, Macropodus,* and *Trichogaster* are well-known bubble nest builders amongst the anabantid fishes but nest materials often vary. *Macropodus cupanus* males depend on mucus bubbles, anchored to floating vegetable materials like *Pistia, Sylvinia,* and *Lemora* plants and have never been found to collect sand grains, detritus, faeces, etc. from the bottom as in *Colisa lalia* and *Trichogaster leeri* (Forselius 1957). Although mating and spawning usually take place after the completion of the nest by the male, mating and nest building in *M. cupanus* may go on simultaneously. Occurrence of spawning in the absence of a nest has also been reported in *C. lalia, C. labiosa, Osphronemus goramy, T. leeri,* and *T. trichopterus* (Forselius 1957). After completion of the nest, the males of most anabantids remain motionless under the nest facing outwards. This has been termed by Forselius as ' nest posting ' of the male. Nest posting of the male has also been observed in *Colisa* and *Trichogaster. Badis badis* males remain motionless at the entrance of their burrows (nests) (Barlow 1962).

The leading to nest movement in *M. cupanus* males is similar to that of *C. lalia, C. labiosa, T. leeri,* and *M. opercularis. Betta* males show semi-erected fins while leading the female to the nest. *Badis badis* males on the other hand settle down under the nest at the sight of a receptive female. If *M. cupanus* males fail to conduct the female to the nest, some will nevertheless persist and eventually succeed. Tinbergen (1953) called this ' persuasion '. Persuasion has also been reported in *C. lalia* (Forselius 1957). Many males, however, instead of exhibiting persuasion become aggressive towards the females which do not respond to leading. Aggressiveness of males under this circumstance has been reported by Forselius (1957) in *C. lalia, T. leeri,* and *T. trichopterus* and by Barlow (1962) in *Badis badis.* We have not observed males leading the female to non-existing nests, as reported for *Pygosteus pungitius* by Morris (1952). Leading to the nest movement has been described in sunfishes by Breder (1936) but he did not mention the manner of leading. While approaching males under the nest, females of *M. cupanus,* like those of *T. leeri*, *M. opercularis*, and *C. fasciata*, swim with head pointed downwards.

When mating has actually begun, each successful enfolding seems to stimulate the male to chase off intruders. Enfoldings in which no eggs are released and no (?) ejection of sperm occurs have been termed by Forselius as ' pseudo-spawning '. Pseudo-spawnings occur several times at the beginning and end of mating.

The upside down posture of the female also occurs in *C. lalia*, *Betta splendens*, and *M. opercularis* but is lacking in *C. fasciata*. *Betta* males take the form of an inverted ' U ' while enfolding. Padmanabhan (1955) stated that spawning in *M. cupanus* occurs only in day-time. We agree with this and have observed that most matings take place between 11 a.m. and 3 p.m. In contrast, most of the matings in *A. testudineus* occurred at night (Mookerjee & Mazumder 1946).

A complete mating cycle in *M. cupanus* lasts from 2 to 5 hours which is a wider range than that stated by Padmanabhan (1955). The number of eggs released in each enfolding averaged 14·1 with variation from 1 to 65 (Table). This is similar to egg production in *C. lalia*, *C. labiosa*, and *C. fasciata*. Jones (1940) stated that the eggs are shot up towards the nest by the force of ejaculation and they float with other eggs. Norman (1936) stated that the eggs are light and they float upwards as a result of buoyancy and not through any intervention by the parents. Padmanabhan (1955) stated that the eggs are picked up only by the male and blown upwards into the nest. But we have observed that the eggs sink and are picked up by both the parents and blown into the nest. Mookerjee & Mazumder (1946) stated that the eggs of *A. testudineus* are shot up by the force of ejaculation and float on the surface.

Duration of enfolding averaged 12·8 seconds with variations from 6 to 22 seconds, which is similar to that of Jones's (1940) observation. Jones (1940) stated that the number of eggs laid by a female is about 300. This was supported by Forselius (1957). Padmanabhan stated that on an average 400 eggs are laid by a female but we observed an average of 646·7 eggs per mating, with variation from 299 to 973 (Table).

The interval between 13 successive spawnings of 7 females averaged 14 days with variation from 7 to 25 days. This agrees with Padmanabhan's (1955) findings of 12 to 15 days.

After the termination of oviposition the male spontaneously becomes aggressive to the female and chases her away from the nest. Most previous workers including Jones (1940), Padmanabhan (1955), and Innes (1956) stated that if the female is not removed from the tank after the termination of spawning she is in most cases killed by the male. Our observations in laboratory aquaria showed that the female is not killed. Forselius (1957) reported that males and females of *C. lalia* and *Betta splendens* can be kept together without much injury. We kept and bred a pair of *M. cupanus* in a tank thrice successively and there was no injury to the female except that her tail fin was partially damaged. All the fry were eaten, however.

Aronson (1949) stated that eggs of oviparous teleosts are shed in a flaccid state but rapidly become hard and turgid, i.e. they ' water harden ' (Breder 1934). Hence, to insure fertilization the male must deposit sperm over the eggs within a very short time. In accord with Aronson we are of opinion that egg-laying and fertilization of eggs in *M. cupanus* take place within first 5-8 seconds of enfolding.

Polygamy in *M. cupanus* has been observed in natural conditions by Padmanabhan (1955), but we have not observed polygamy in aquaria. A receptive female was introduced in a tank with a male guarding a brood, there was no mating and the female died in ' egg bound ' condition. Tavolga (1954) reported polygamy in *Bathygobius soporator.*

SUMMARY

This paper presents descriptive and quantitative data on the reproductive behaviour of *Macropodus cupanus* in laboratory aquaria in Calcutta.

Reproductive behaviour has been analysed in three divisions : (1) Pre-mating behaviour, which includes sexual displays of both sexes prior to enfolding or copulation, (2) Mating behaviour, which includes the processes of enfolding, egg deposition, and fertilization, and (3) Post-mating behaviour, which includes behavioural interactions between the sexes after enfolding and during parental care.

A total of 50 matings have been observed with complete and accurate data on 44 of them, involving 2128 enfoldings. The average number of enfoldings per mating was 48·4 ; average duration of mating time 169·9 minutes ; average number of eggs per mating 646·7 ; average number of eggs per enfolding 14·1 ; average duration of enfolding 12·8 seconds ; and average interval between successive enfoldings 3·4 minutes. Thirteen successive matings of seven different females occurred at an average interval of 14 days.

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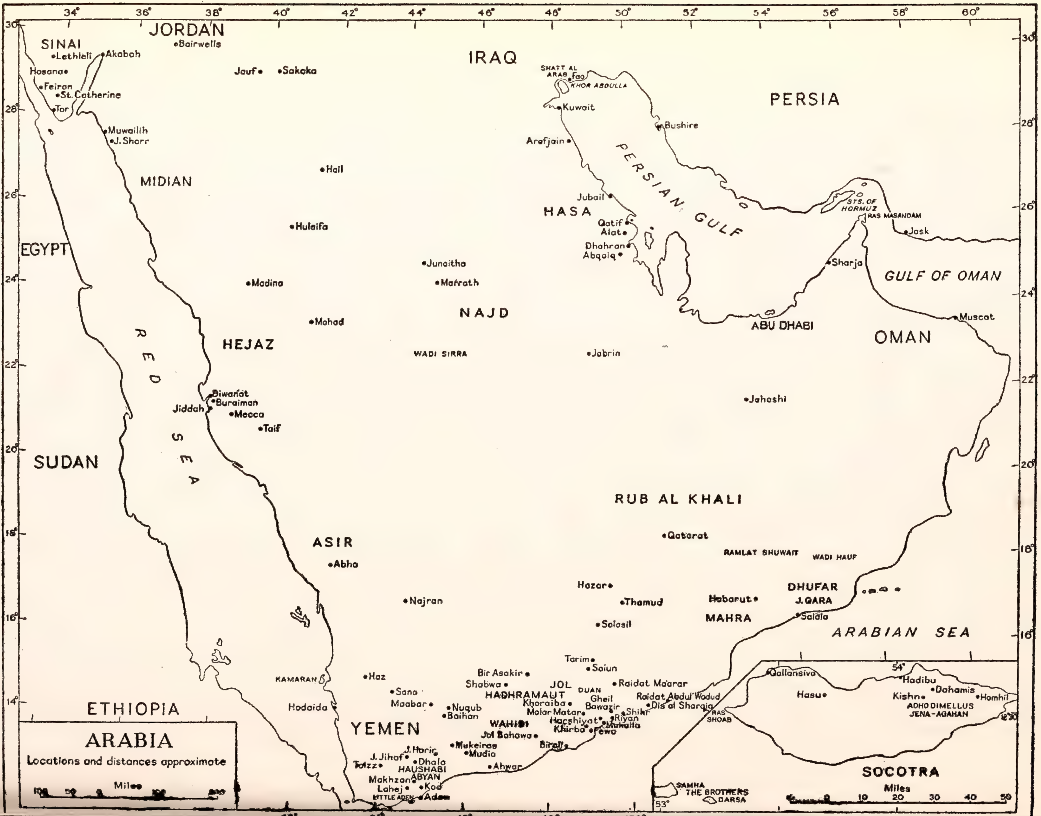
ARABIA
Locations and distances approximate
Miles
SINAI
Lethleli
Akabah
Hasana
Feiran
St. Catherine
Tor
JORDAN
Bairwells
Jauf
Sakaka
IRAQ
SHATT AL ARAB
Fao
KHOR ABDULLA
Kuwait
PERSIA
Bushire
Arafjain
PERSIAN GULF
Muwailih
J. Sharr
MIDIAN
Hail
Jubail
HASA
Qatif
Alat
Dhahran
Abqaiq
STS. OF HORMUZ
RAS MASANDAM
Jask
Huleifa
EGYPT
Junaitha
Mafrath
Sharja
GULF OF OMAN
Madina
NAJD
Muscat
Mahad
ABU DHABI
OMAN
RED SEA
HEJAZ
WADI SIRRA
Jabrin
Biwanat
Buraimah
Jiddah
Mecca
Taif
Jahashi
SUDAN
RUB AL KHALI
Qatarat
RAMLAT SHUWAIT
WADI HAUF
ASIR
Abha
Hazar
DHUFAR
Najran
Thamud
Habarut
J. QARA
MAHRA
Salala
Solosil
ARABIAN SEA
Tarim
Soiun
Bir Asakir
KAMARAN
Haz
Shabwa
JOL
DUAN
Raidat Ma'arar
Qallansiva
Hadibu
Sana
HADHRAMAUT
Gheil
Raidat Abdul Wadud
Hasu
Kishn
Dahamis
Homhil
Hodaida
Maabar
Nuqub
Baihan
Khoraiba
Bawazir
Dis al Sharqia
ADHO DIMELLUS
JENA-AGAHAN
ETHIOPIA
Molar Matar
Shihr
RAS SHOAB
YEMEN
WAHIDI
Hacshiyat
Riyan
Khirba
Mukalla
Fewa
Jol Bahawa
Bir Ali
Mukeiras
Mudia
J. Horia
J. Jihaf
Dhala
Taizz
HAUSHABI
Ahwar
SOCOTRA
Makhzan
ABYAN
Lahej
Kod
LITTLE ADEN
Aden
SAMHA
THE BROTHERS
DARSA
Miles

The Snakes of the Arabian Peninsula and Socotra

BY

N. L. CORKILL AND J. A. COCHRANE

(*With a map*)

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INTRODUCTION

In the years 1948-1961, the senior author, while working in Saudi Arabia and the Aden Protectorate, took what interest duties permitted in the local snakes. A number of specimens were left in fairly representative collections in the Biological Department of Aden College and in the two Health Services Training Centres, situated one in Makhzan Hospital in the Western Aden Protectorate (now the Federation of the Arab Amirates of the South) and the other in Mukalla Hospital in the Qu'aiti State of the Eastern Aden Protectorate. A number were also sent to the British Museum, where a more systematic examination was possible. The data resulting are recorded in this paper. Many specimens were too mutilated for complete scale counts to be made.

While consulting the literature it seemed useful to review that relating to distribution and the vernacular names of those snakes occurring in the Arabian Peninsula as a whole, taking the 30th Parallel as an approximate but convenient northern limit, and including Sinai. The seas surrounding the Peninsula are included for the sea snakes. The main interest of the paper relates however to the additional records from Western Saudi Arabia, the Yaman, and Aden Territory including the island of Socotra.

The collection of specimens was made largely through the staff of various health services in rural areas and as a result a considerable amount of information was obtained about vernacular names and folk belief and practice relating to snakes and snake-poisoning. Apart from clear-cut local applications of the names of snakes, this traditional material will be dealt with elsewhere.

Unless otherwise stated, colour when mentioned refers to that of specimens preserved in alcohol or formalin or both. An unhappily large number of specimens are necessarily shown from ' Aden Protectorate ' because the labels giving more precisely the localities in which they were collected were lost or mutilated in repeated packings.

Physiographically, the Arabian Peninsula shows much uniformity, that of a desert of rock and sand, scarred in larger and smaller areas with volcanic residues in the shape of extinct craters and fields of lava. The rocky features occur both as small hills and in major systems, the latter most notably in the mountains of the Yaman with peaks rising to 12,000 feet, which offer a marked contrast in vegetation and humidity with most of the Peninsula. In central Arabia the arid Jabal Tawaik system is a dominant feature. Parallel with the southern coast the mountains continue the Yaman system through the Hadhramaut complex to reach the relatively fertile Jabal Qara and the hills of Oman.

Apart from much of the Yaman, Jabal Qara, isolated areas of cultivation and oases, the Peninsula is characteristically arid, a large part of the south-east constituting the desert known as the Rub-al-Khali, i.e. the ' Empty Quarter '. Where oases and cultivation exist, they are watered naturally by springs or floods, or with man's intervention by means of wells, dams, and the bunding of storm water.

Rainfall is largely sporadic and localized, and may be scanty, or so temporarily violent that large watercourses, wadis, may be heavily flooded and damage to life, cultivation, and property may result. The winter is cool and at the higher altitudes the temperature may approach freezing point. The summer is relatively hot everywhere, in most places exceeding at times 100°F.

Humidity is high on the coasts which are complexes of rock and sand; reefs of rock and coral are common and lagoons, marsh, and estuarine conditions occur in places where the main watercourses discharge their occasional or perennial floods into the sea.

Urbanization does not seem to have had much effect on reptilian ecology so far, for there are few really large towns or seaports apart from Jiddah, Mecca, and Aden and even in these, snakes such as *Coluber rhodorhachis*, *Spalerosophis*, *Malpolon*, and even *Cerastes* and *Echis* are encountered.

SYSTEMATIC LIST

BOIDAE

1. *Eryx colubrinus* (Linnaeus)
2. *Eryx jaculus* (Linnaeus)
3. *Eryx jayakari* Boulenger

COLUBRIDAE[1]

4. *Boaedon arabicus* Parker
5. **Brachyophis revoili* Mocquard
6. *Coluber elegantissimus* (Günther)
7. *Coluber gemonensis* (Laurenti)
8. *Coluber karelinii* Brandt
9. *Coluber nummifer* Reuss
10. *Coluber rhodorhachis* (Jan)
11. *Coluber rogersi* Anderson
12. *Coluber socotrae* (Günther)
13. *Coluber thomasi* Parker
14. *Coluber variabilis* (Boulenger)
15. *Coluber ventromaculatus* Gray
16. *Coronella somalica* Scortecci
17. *Dasypeltis scabra* (Linnaeus)
18. **Ditypophis vivax* Günther
19. *Eirenis arabica* Haas
20. *Eirenis coronella* (Schlegel)
21. **Lycophidion capense* (Smith)
22. *Lytorhynchus diadema* (Duméril & Bibron)
23. *Lytorhynchus sinai* Schmidt & Marx
24. **Malpolon moilensis* (Reuss)
25. **Malpolon monspessulana* (Hermann)
26. *Natrix dubbiosii* Scortecci
27. *Philothamnus semivariegatus* Smith
28. **Psammophis punctulatus* Duméril & Bibron
29. **Psammophis schokari* (Forskål)
30. *Rhynchocalamus arabicus* Schmidt
31. *Rhynchocalamus melanocephalus* (Jan)
32. *Spalerosophis diadema cliffordi* (Schlegel)
33. **Telescopus dhara* (Forskål)
34. **Telescopus hoogstraali* Schmidt & Marx

ELAPIDAE

35. *Naja haje arabica* Scortecci
36. *Walterinnesia aegyptia* Lataste

HYDROPHIDAE

37. *Astrotia stokesii* (Gray)
38. *Enhydrina schistosa* (Daudin)
39. *Hydrophis cyanocinctus* Daudin
40. *Hydrophis fasciatus fasciatus* (Schneider)
41. *Hydrophis lapemoides* (Gray)

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[1] The Opisthoglypha are marked with an asterisk.

42. *Hydrophis mamillaris* (Daudin)
43. *Hydrophis ornatus ornatus* (Gray)
44. *Hydrophis spiralis spiralis* (Shaw)
45. *Lapemis curtus* (Shaw)
46. *Microcephalophis cantoris* (Günther)
47. *Microcephalophis gracilis* (Shaw)
48. *Pelamis platurus* (Linnaeus)
49. *Praescutata viperina* (Schmidt)

LEPTOTYPHLOPIDAE

50. *Leptotyphlops burii* (Boulenger)
51. *Leptotyphlops filiformis* (Boulenger)
52. *Leptotyphlops macrorhyncus* (Jan)
53. *Leptotyphlops macrura* (Boulenger)
54. *Leptotyphlops nursii* (Anderson)
55. *Leptotyphlops phillipsi* Barbour

TYPHLOPIDAE

56. *Typhlops braminus* (Daudin)
57. *Typhlops socotranus* Boulenger
58. *Typhlops vermicularis* (Daudin)

VIPERIDAE

59. *Atractaspis microlepidota andersoni* Boulenger
60. *Atractaspis engaddensis* Haas
61. *Bitis arietans* (Merrem)
62. *Cerastes cerastes* (Linnaeus)
63. *Echis carinata pyramidum* (Geoffroy St. Hilaire)
64. *Echis colorata* Günther
65. *Pseudocerastes fieldi* Schmidt
66. *Pseudocerastes persicus* (Duméril & Bibron)
67. *Vipera lebetina* (Linnaeus)

MATERIAL AND LITERATURE

A large proportion of the historic material contributing to this review is in the British Museum (Natural History) having been collected by travellers such as Burton from Midian, Blunt from the Hadhramaut, and Thomas and Philby from southern and western Arabia, or by officials and other workers in the country such as Jayakar, Yerbury, Nurse, and Percival, from Muscat and Aden.

American Museums (Chicago and Harvard) have received material from sources mostly in the northern and eastern areas and Italian workers, notably Scortecci, have collected and recorded material from the Yaman.

Major organized expeditions have been: that of the British Museum to south-west Arabia in 1937-1938 and the five to Socotra, of Balfour in 1879-1880, Schweinfurth in 1881, that of the British and Liverpool Museums in 1898, Steindachner's visit to the island in 1899, and the Oxford University Expedition of 1956. Of recent years the Desert Locust Survey have sent specimens to the British Museum from various parts of the Peninsula.

In the years 1948-1961 the senior author collected some 205 specimens, or records of snakes seen dead or alive but not collected, in Saudi Arabia or Aden Territory, apart from a few sent to him from the Yaman and Muscat. Acknowledgements to most contributors from the field are made below.

The literature covering the snake fauna of the Peninsula starts formally with Forskål (1775, *P. schokari*), but the first comprehensive compilation was that of Anderson (1896) an indispensable work of reference and general enlightenment. The catalogues of Boulenger (1893, 1894, and 1896) on the collections in the British Museum (Natural History) provide a yet broader basis for a starting point for any work on Arabian, as indeed on all snakes.

Notable later contributions have been those of Barbour (1914) and Schmidt (1933, 1939, 1953) on the Peninsula in general, Scortecci (1932) and Scott (1947) on the Yaman, Parker (1930, 1931, 1932, 1933, 1938, 1941, and 1949) on south-west Arabia and Socotra on new species and from a critical taxonomic standpoint, Haas (1943, 1957, and 1961), Haas & Battersby (1959), Schmidt & Marx (1956) on the northern and eastern snakes, Günther (1881), Forbes (1903), Boulenger (1903), and Steindachner (1903) on Socotran forms, and Smith (1926, 1943), and Volsøe (1939) on the sea snakes.

The writings of Abdullah Mansur (1911), Doughty (1921 ed.), Philby (1939), Thomas (1932), Scott (1947), Dickson (1949), and Thesiger (1959), with on-the-spot knowledge of Arabia contain facts of interest from the field.

TAXONOMIC AND FIELD DATA

The snakes discussed in this paper are those recorded in the literature as coming from the Arabian Peninsula, those preserved in the British Museum, which have been collected in the area under discussion but not previously reported, and a further 205 collected by the senior author. Of these last 29 are from Saudi Arabia, and 176 from Aden Territory. Of the 205, 99 are now in the British Museum.

The commonest snakes of the area are *Coluber rhodorhachis* and *Spalerosophis diadema cliffordi*. The commonest poisonous snakes are

Cerastes cerastes and the *Echis* vipers, *E. carinata* being commoner than *E. colorata*.

Some species have peripheral distribution only ; in the north such are *Eryx jaculus*, *Eryx colubrinus*, *Coluber elegantissimus*, *Coluber rogersi*, *Coluber nummifer*, *Coluber ventromaculatus*, *Eirenis arabica*, *Eirenis coronella*, *Lytorhynchus sinai*, *Malpolon monspessulana*, *Rhynchocalamus melanocephalus*, *Telescopus hoogstraali*, *Leptotyphlops macrorhynchus*, *Typhlops vermicularis*, *Atractaspis engaddensis*, and *Pseudocerastes fieldii*, and in the north-east bordering the Persian Gulf are *Coluber karelinii* and *Walterinnesia aegyptia*. The Yaman has a record for *Vipera lebetina*, an extrusion well south of its characteristic range. In the west and south, species with more typically African distribution are *Dasypeltis scabra*, *Lycophidion capense*, *Philothamnus semivariegatus*, *Psammophis punctulatus* (a doubtful record), and *Bitis arietans*. So far as present records go, peculiar to the south are *Rhynchocalamus arabicus*, *Coluber thomasi*, *Leptotyphlops burii*, *Leptotyphlops nursii*, and *Atractaspis microlepidota andersoni*.

The snakes of Socotra are restrictedly endemic with the exception of *Echis colorata*, represented by a single record with some doubt cast on the locality of origin.

There are certain Arabic names for snakes occurring in many or all Arab countries, found for the most part in standard Arabic dictionaries. They thus deserve to be considered in some degree as ' classical '. They may apply to snakes in general, in the sense of ' serpent ', or to categories of snakes that have obtrusive attributes such as horns, or are notably small or large, or are vipers, or dangerously poisonous, or move very quickly, or burrow in the earth, or are thought to do so.

In the general sense of 'serpent' are used *hanash*, *tha'aban*, and *haiya* and, in the Hejaz and the Hasa area, *dab*. Of small snakes, *um shibr* = ' of a span ' is used. Spotted snakes are commonly called *raqta* = ' spotted '. Swift-moving whippy forms with no other outstanding character are called *zarrag* = ' the lanced ' or ' the projected ', or some variant of the same word. Snakes with burrowing habits are called *daffan* = ' burier ' or some variant. In Abu Dhabi in the Trucial States *ghul* = ' demon ' is commonly used in addition to *haiya* and *hanash*, though it seems specially to apply to the cobra.

The word *afa*=' viper ' has many variants and from Libya (where *liffa* or *laffa* would seem to represent *al afa*) to Delhi and, especially in Arabia, relates to the common, well-known and feared *Echis* and *Cerastes* vipers. These last two groups of snakes, which produce a rustling noise by rubbing their scales together while coiling about, have also a number of colloquial mimetic names inspired by this noise, and involving the sounds *f* or *sh*. Keimer (1945) has discussed at length the relationship of the sound *f* to the Egyptian hieroglyph in the form of the *Cerastes* vipers, horned or unhorned. Also the word *afa* would appear to equate with the Hebrew *epheh*=' serpent '.

Parker (1931) has recorded from Dhufar several Shahari names for snakes collected by Bertram Thomas ; one of these *shaltum*, it appears, is possibly used of snakes in general. At Habarut on the Mahra mainland the senior author collected the word *araraidh*, which appeared to be used of a snake in a general sense but may be a corruption in form and an application of the Arabic *al araidh*=' the broad one ', that is the cobra, for in Libya *abu araidha* is used of *Naja haje*. On Socotra, for ' snake ' in general in the Socotri tongue *shudhim* was said to be used.

The data given below unless otherwise stated refer to material from within the Peninsula only, with a slight element of margin as regards the northern species.

BOIDAE

Eryx colubrinus (Linnaeus)

Eryx thebaicus, Scortecci, 1932, p. 40, (Yaman, 1).

The species is marginal being common in Egypt and the northern Sudan.

Scale count. The scale range given by Boulenger (1893 p. 122) for non-Arabian specimens is Sc. 47-53, V. 171-197, C. 19-28, A. 1. Scortecci gives Sc. 55 at mid-body.

Eryx jaculus (Linnaeus)

Eryx jaculus Duméril & Bibron, 1844, p. 463, (Arabia, +) ; Anderson, 1896, pp. 70, 86, 90, (*in litt.*).

Scale count. The scale range in Boulenger (1893, p. 125) for Greece to Afghanistan is Sc. 40-50, V. 165-200, C. 15-34, A. 1.

Eryx jayakari Boulenger

Eryx jayakari Boulenger, 1888, p. 508, (Muscat, 1) ; idem, 1893, p. 129, (*in litt.*) ; Anderson, 1896, pp. 82, 88, (*in litt.*) ; Parker, 1931, p. 514, (Jahashi, Rub-al-Khali, 1) ; idem, 1931 (a), p. 228, (*in litt.*) ; idem, 1932, p. 341, (*in litt.*) ; idem, 1938, p. 481, (Southern Hejaz, +) ; Haas, 1957, p. 79, [Abqaiq, Dhahran, Al Alat (oilfields); Sharja, 15] ; idem, 1961, p. 19 (Abqaiq, Al Hasa, 2).

Records. The senior author collected specimens from Jiddah, Little Aden, Nuqub in the Baihan area and Al Hazar and Shaq al Maatif near Thamud.

Scale count. The scale count for the Arabian examples of this species that have been recorded in the literature and taken from specimens in the British Museum are Sc. 37-51, V. 158-184, C. 16-22, A. 1.

Coloration. The specimen taken in Little Aden was very much darker than the specimens from Baihan and Thamud, *Vernacular names.* Parker (1931a) records the name *difen* from the Rub-al-Khali. This recalls the word *dafn*, ' burier ', of the Aden Protectorate, which though more usually applied to the *Echis* snakes, may also be applied to *Eryx jayakari.* In Baihan the snake was called *badan* and *badhan*, suggestive of the Hebrew *pethen* = ' snake ' in general, and it is of interest that there was formerly a Jewish community in Baihan.

Habitat. All the specimens were taken from sand.

Remarks. Two specimens that were handled made no attempt to bite.

COLUBRIDAE

There have been 31 species and subspecies of the Family recorded from the Peninsula, including 9 of the Opisthoglypha, the back-fanged division. Certain snakes of this division are relatively large, have striking markings and are frequently encountered, and since they possess fangs capable of inoculating venom and producing appreciable, albeit not lethal, reactions they tend to attract specifically applicable folk names.

Boaedon arabicus Parker

Boaedon arabicus Parker, 1930, p. 594 (Al Kubar in Haushabi area, 5) ; Scortecci 1932, p. 41 (Sana in Yaman, 5).

Boaedon lineatus arabicus Parker, 1941, p. 4 (Jabal Harir, 1) ; idem, 1949, p. 51 (*in litt.*) ; Schmidt, 1953, p. 260 (Yaman, 1).

Records. The senior author's collection included one specimen from either the Yaman or the Western Aden Protectorate.

Scale count. The scale count range of the Arabian specimens from the literature and of the specimens in the British Museum is Sc. 27-33, V. 220-250, C. 47-62, A. 1. The specimen collected by the senior author had a higher number, 35, of mid-body dorsal scales.

***Brachyophis revoili** Mocquard

Brachyophis revoili, Scortecci, 1932, p. 46 (Sana, Yaman, 1).

Brachyophis revoili revoili, Parker, 1949, p. 81, (*in litt.* and discussion).

Scale count. The scale count given by Scortecci for his Yaman specimen is V. 106, C. 13.

Coluber elegantissimus (Günther)

Zamenis elegantissimus Günther, 1878, p. 977 (Muwaylah in Midian, 1) ; Hart, 1891, p. 209 (Akabah, 1) ; Boulenger, 1893, p. 402 (*in litt.*) ; Anderson, 1896, pp. 82, 88, (*in litt.*).

Coluber elegantissimus, Parker, 1949, p. 45, (affinity with *socotrae* and *florulentus*).

Scale count. The scale count given by Boulenger (1893, p. 402) is Sc. 19, V. 197-200, C. 79-83, A. 2.

Coluber gemonensis (Laurenti)

Zamenis atrovirus, Shaw, Hart, 1891, p. 209, (Wadi Nasb in Sinai, 1).
Coluber viridiflavus var. *carbonaria* Bonaparte, 1839.

Scale count. Boulenger (1893, p. 396) gives the scale count as Sc. 17-19, V. 171-250, C. 87-130, A. 2.

Coloration. The specimen recorded by Hart was of the black *carbonarius* variety.

Coluber karelinii Brandt

Zamenis karelinii, Bedriaga, 1879, p. 44, (Ras Masandam, +); Anderson, 1896, pp. 82, 86, 90, (*in litt.*) ; Boulenger, 1893, p. 401, (*in litt.*).

Scale count. The count given by Boulenger for specimens from Persia and Afghanistan is Sc. 19, V. 193-212, C. 85-110, A. 1.

Coluber nummifer Reuss

Zamenis nummifer, Barbour, 1914, p. 88, (Fairan in Sinai, 1).

Scale count. Boulenger (1893, p. 407) gives the count as Sc. 23-25, V. 197-216, C. 79-101, A. 1 or 2.

Coluber rhodorhachis (Jan)

Zamenis ventromaculatus, Gray, part, Günther, 1858, p. 106 (Muscat, +) ; Boulenger, 1887, p. 407, (Muscat, +).
Zamenis florulentus, Parenti & Picaquia, 1886, p. 68 (Aden, +).
Zamenis ladacensis, Boettger, 1892, p. 62 (Aden).
Zamenis rhodorhachis Jan, 1864, p. 356 (all localities Persian) ; Günther, 1878, p. 977 (Midian) ; Boulenger, 1891, p. 632, (*in litt.*) ; idem, 1893, p. 398, (*in litt.*) ; Anderson, 1895, p. 635, (Aden, 4) ; idem, 1896, pp. 51, 82, 86, 89, 116, (*in litt.* and Hadhramaut, 4) ; idem, 1898, p. 252, (*in litt.*) ; idem, 1901, p. 137 (Abyan, 1) ; Barbour, 1914, p. 88, (Fairan in Sinai, 1).
Coluber rhodorhachis, Parker, 1931, p. 514 (Qara Mts. and Dhufar, 9) ; idem, 1931 (a), p. 228, (*in litt.*) ; idem, 1938, p. 481 (Southern Hejaz) ; idem, 1949, p. 30, (taxonomy discussed) ; Schmidt, 1939, p. 73 (Aden, 1) ; idem, 1941, p. 165 (Wadi Sirra & Jiddah, 4) ; idem, 1953, p. 260 (Hodaida & Sana, 2) ; Schmidt & Marx, 1956, p. 29 (Wadi al Shaikh in Sinai, 3) ; Scortecci, 1932, p. 39 (Yaman, 5).

Records. Further records based on specimens collected by the senior author are Jiddah, Buraiman, Abha, Jol Bahawa, Bir Ali, Mukalla, Dis, Khirba, and Hazar. The positions of these localities are shown on the map.

Scale count. The scale count for the Arabian examples of this species that have been recorded in the literature and taken from specimens in the British Museum are Sc. 19, V. 210-260, C. 119-148, A. 2. The specimens from the senior author's collection fall within this range.

Coloration. The colour in these snakes seen alive was grey, with darker markings, becoming darker in alcohol. A vertebral stripe was present in some specimens. Boulenger (1893, p. 399) reports that in Persian specimens the stripe is pink or red, but in the Arabian specimens in life the stripe is drab.

Vernacular names. Parker (1931a, p. 229) records the Shahari names for this snake in the Qara Mountains and Dhufar as *difen*, *ojem*, and *shaltum*. In Aden Territory this species is known as *al aghbar*, *al aghbari*, and *al ghabr*, all meaning ' the grey snake ', and also commonly as *tarrad* or ' chaser ' and *zarraq*=' lancer ' or ' projector '. These last two names, however, are used for any slender, fast-moving snake.

Habitat. Specimens were found in a garden, a mosque tank, and on a sandy sea-shore. It is the commonest snake found near human habitation in Aden Territory, both in built-up areas and in the open country, and is often found in houses. Five specimens fell out of the roofing of a room following anti-mosquito spraying with BHC.

Diet. Schmidt & Marx (1956, p. 29) recorded a skink in the stomach contents of a male specimen. Another specimen, taken from a house in Jiddah, contained a bird.

Temperament. One specimen picked up on an early June morning on a sand-and-gravel track near Mukalla bit vigorously when it was handled. When it was released at some distance from a land-rover, it returned twice to the car, climbing under the bonnet and later on to the rear axle. Two other specimens also bit when handled. There was no reaction to the bites.

Coluber rogersi Anderson

Coluber rogersi, Schmidt & Marx, 1956, p. 29 (Wadi Lathlali in Sinai, 1).

Scale count. The count was Sc. 19, V. damaged, C. 104. Boulenger (1896, p. 623) gives a scale range for Egyptian specimens of Sc. 19, V. 197-201, C. 95-105, A. 2.

Coluber socotrae (Günther)

Zamenis socotrae Günther, 1881, p. 463 (Socotra, 3) ; Boulenger, 1893, p. 408, (*in litt.*) ; idem, 1903, p. 89 (Hadibu, 1).

Zamenis socotrae, Steindachner, 1903, p. 14 [Tamarida (= Hadibu), Ras Shoab, Kallarsiye, Hakari Islet, Samhah Island in Brothers Group, +].

Coluber socotrae, Parker, 1949, p. 42 and 44 (*in litt.*).

Records. In addition to the localities recorded in the literature, there are two specimens in the British Museum, one collected at Hanefu, the other labelled simply 'Socotra'. The senior author's collection includes three specimens from the island, two collected in the hills near Hadibu and one from Hasu between Qathb and Qallansiya (=Kallansiye above).

Scale count. Parker (1949, p. 41) gives the scale count Sc. 23, V. 219-227, C. 113-124, A. 2. The senior author collected a specimen with a caudal count of 133; the other counts were within the range given above.

Coloration. Boulenger (1903, p. 90) gives a description of the colour as ' head olive above ; body with olive sometimes black-edged transverse bands, separated by narrower salmon-red interspaces ; belly yellowish or pale olive.' A young specimen collected by the senior author was seen alive. The colour was canary yellow, barred dorsally with bright cobalt blue. On preservation it faded to grey, barred with black.

Vernacular names. The Socotri name *bikaili* was applied specifically to the young specimen described above. The word *shudhim* was also used, but this clearly meant ' snake ' in a general sense.

Coluber thomasi Parker

Coluber thomasi Parker, 1931, p. 514 (Qara Mountains and Dhufar, 1); idem, 1931a, p. 228, (*in litt.*).

Records. The senior author's collection contained a young specimen from the Aden Protectorate, the precise locality being unrecorded.

Scale count. The type specimen has the scale count Sc. 15, V. 158, C. 80, A. 2. The specimen collected by the senior author differed only in the caudal count, which was 81.

Coloration. In preservation, the young specimen is creamy-white, with black dorsal markings. A prominent row of large spots in the midline of the ventral surface of the tail was a ready guide to identification.

Coluber variabilis (Boulenger)

Zamenis variabilis Boulenger, 1905, p. 178 (Al Kubar in Haushabi State, 10).

Coluber variabilis, Scortecci, 1932, p. 43 (Sana in Yaman, 1) ; Parker, 1941, p. 4 (Jabal Harir, 1).

Records. The senior author's collection contained a specimen from Wadi Shadhan in the Hejaz, collected by Mr. G. Popov of the Desert Locust Survey.

Scale count. The scale count for the other Arabian specimens of this species is Sc. 17, V. 155-175, C. 80, A. 2. The specimen from Wadi Shadhan was outside this range having Sc. 19, V. 187, C. 82, A. 2.

Coluber ventromaculatus Gray

Coluber ventromaculatus, Hart, 1912, p. 209 (Wadi Zalagah, Sinai, 1) ; Schmidt, 1939, p. 74 (Al Jubail, north of Bahrain, 1) ; Dickson, 1949, p. 471 (Kuwait, 1) ; Haas, 1957, p. 79 (Qara Mountains and Dhahran, 5) ; idem, 1961, p. 20 (Abqaiq and Al Hasa, 4).

Scale count. The range was Sc. 19, V. 203-214, C. 91-119, A. 2.

Coronella somalica Scortecci

Coronella somalica Scortecci, 1932, p. 46, (Yaman, 1).

Scale count. The scale count was Sc. 21, V. 209, C. 80, A. 2.

Dasypeltis scabra (Linnaeus)

Dasypeltis scaber, Parker, 1949, p. 67 (Al Kubar in Haushabi State, +).

Dasypeltis scabra, Gans, 1959, p. 78, (*in litt.*).

Records. The senior author saw a preserved specimen at the Little Aden oil refinery in 1951, which had been taken locally. The markings suggestive of *Echis carinata* though faint, were defined.

Scale count. The recorded counts are Sc. 23, V. 235-244, C. 61-64.

Remarks. Corkill (1956) and Gans (1961) have noted the mimicry of *Echis carinata* by *Dasypeltis scabra* in shape, colour, and behaviour.

***Ditypophis vivax** Günther

Ditypophis vivax Günther, 1881, p. 463 (Socotra, 1); Boulenger, 1896, p. 46, (*in litt.*); idem, 1903, p. 90 (Hadibu, Adho Dimellus, Jena-Agahan, Homhil, 8); Steindachner, 1903, p. 14 (Shoab, Wadi Felink, +); Parker, 1949, p. 89, (*in litt.* and discussion).

Records. In addition to the specimens recorded in the literature there are six specimens in the British Museum from Hadibu and Kishn including three collected by the 1956 Oxford University Expedition to Socotra.

Scale count. The recorded counts are Sc. 21-23, V. 142-154, C. 37-44, A. 1.

Coloration. The colour is recorded by Boulenger (1903, p. 91) as reddish or sandy grey with or without spots.

Remarks. The colouring of the snake, in conjunction with its short tail, keeled scales, single subcaudals, and vertical pupil gives a superficial appearance very similar to the mainland viper *Echis colorata.* Günther (see below) recorded the latter snake from Socotra, but no specimen has been collected from there since. Nor has any other species been recorded which is non-endemic. The accuracy of the collecting data of Günther's specimen has been questioned in the light of these points. The present Socotri Health Assistant on the island was trained at Mukalla on the mainland and was familiar with the *Echis* vipers, which are fairly common near Mukalla. He insisted that the *dhuffa* (the mainland name for both *Echis* species) occurred on Socotra, where it was known as *diatib.*

It would appear that the two genera may be easily confused by the less well-informed, and the statement made in the PERIPLUS OF THE ERYTHREAN SEA (*c.* 100 A.D.) and quoted by Boulenger (1903, p. 91), that there are a great many vipers on Socotra, is possibly also evidence of easy confusion. Further collecting on the island would decide whether or not *Echis colorata* occurs there.

Eirenis arabica Haas

Eirenis arabica Haas, 1961, p. 20 (Abqaiq, 1).

Scale count. The scale count was Sc. 15, V. 147, C. 52, A. 1.

Eirenis coronella (Schlegel)

Eirenis coronella, Barbour, 1914, p. 89 (Petra, 3, St. Catherine in Sinai, 2) ; Schmidt & Marx, 1956, p. 30 (St. Catherine's Monastery and Al Raba, 2).

Scale count. The scale count was Sc. 15, V. 140-158, C. 39-62, A. 2.

***Lycophidion capense** (Smith)

Lycophidion capense, Scortecci, 1932, p. 43 (Sana, Yaman, 1); Parker, 1949, p. 54, (*in litt.*).

Scale count. The scale count was Sc. 25, V. 162, C. 35.

Lytorhynchus diadema (Duméril & Bibron)

Lytorhynchus diadema, Boulenger, 1887, p. 407 (Muscat, 1); idem, 1893, p. 415, (*in litt.*); Maatschie, 1893, p. 19 (Aden, +); Anderson, 1896, pp. 82, 89, (*in litt.*); idem, 1898, p. 272, (*in litt.*); Schmidt & Marx, 1956, p. 30 (Al Raba, 1).

Lytorhynchus diadema arabicus, Haas, 1957, p. 80 (Abqaiq, Dhahran, Moraiwa Post, 9); idem, 1961, p. 21 (Abqaiq in Al Hasa, 1).

Records. The present collection contained one specimen from Gahma in Saudi Arabia, collected by Mr. G. Popov of the Desert Locust Survey.

Scale count. The scale count range for the Arabian specimens is Sc. 19, V. 161-182, C. 35-43, A. 2.

Lytorhynchus sinai Schmidt & Marx

Lytorhynchus sinai Schmidt & Marx, 1956, p. 30 (Wadi Fairan in Sinai, 1).

Scale count. The scale count was Sc. 17, V. 184, C. 94, A. 2.

***Malpolon moilensis** (Reuss)

Coluber moilensis Reuss, 1834, p. 142 (Moilah in Midian, 1).

Coelopeltis moilensis, Anderson, 1895, p. 656 (Aden, 1); idem, 1896, pp. 52 and 82, 89, (*in litt.* plus Hadhramaut, 2); idem, 1898, p. 293 (*in litt.*); idem, 1901, p. 137 (Abyan, 1); Boulenger, 1896, p. 144 (Aden, Hadhramaut and Muscat, 3).

Malpolon moilensis, Parker, 1931, p. 514 (Wadi Hauf in Rub-al-Khali, +); idem, 1931a, p. 228, (*in litt.*); idem, 1938, p. 481 (Jiddah, 1); Haas, 1957, p. 47 (Abqaiq, Dhahran, 9); Haas & Battersby, 1959, p. 202 (Bir Asakir, Jol, Jabrin, 5).

Records. There are 13 specimens recorded by the senior author from Jiddah, Little Aden, Mukalla, and Bir Asakir.

Scale count. The recorded scale range for the Arabian specimen is Sc. 17, V. 139-176, C. 53-73, A. 2.

Vernacular names. Parker (1931a, p. 228) records the name *zaraq* from the Rub-al-Khali. There are a number of names in the Aden Protectorate that have been applied to this, as also other snakes; they are *hanash*, *haiya*, *tarrad*=' chaser,' and *raqta*=' spotted '. The name *zarrag* =' lancer ' or ' projector ' might also be expected in this area. A dead one, seen at Bir Asakir, was called *hanfish* by the garrison (see *Naja haje arabica* below).

Habitat. All the specimens were taken in sandy places, two on tracks.

Remarks. The senior author was told that the *hanfish* blew out its throat. This suggests that the species was confused with a cobra although Boulenger (1920, p. 399) writes of a report of a specimen in Iraq dilating its neck, and Angel & Lhote (1938, p. 367) state that in the French Sahara the species erects, and dilates its neck like *Naja*.

***Malpolon monspessulana** (Hermann)

Coelopeltis monspessulana, Hart, 1891, p. 209 (Jabal Hartah in Sinai, +) ; Werner, 1893, p. 389 (Sinai, 1) ; Anderson, 1896, pp. 82, 91, (*in litt.*).

Scale count. Counts recorded are Sc. 17, V. 176, C. 112, A. 2.

Natrix dubbiosii Scortecci

Natrix dubbiosii Scortecci, 1932, p. 40 (Yaman, 1).

Scale count. The scale count was Sc. 19, V. 167, C. 61, A. 2.

Philothamnus semivariegatus Smith

Philothamnus semivariegatus, Scortecci, 1932, p. 45 (Sana, Yaman, 1) ; Parker, 1949, p. 58, (*in litt.*).

Scale count. The scale count was Sc. 15, V. 176, C. 94.

***Psammophis punctulatus** Duméril & Bibron

Psammophis punctulatus Duméril & Bibron, 1854, p. 897 (Arabia, 1) ; Parker, 1949, p. 68, (*in litt.*, validity of the record from Arabia questioned).

***Psammophis schokari** (Forskål)

Coluber schokari Forskål, 1775, p. 14 (Yaman, +).

Coluber lacrymans, Reuss, 1834, p. 34 (Arabia, +).

Psammophis lacrymans, Boulenger, 1895, p. 538, (*in litt.*) ; Anderson, 1895, p. 635 (Haithalmin and Shaikh Uthman in Aden area, 2).

Psammophis schokari, Anderson, 1896, pp. 83, 87, 89, (*in litt.* plus Hadhramaut, 1) ; idem, 1898, p. 299, (*in litt.*) ; idem, 1901, p. 137 (Abyan, 1) ; Boulenger, 1896, p. 158, (*in litt.*); Barbour, 1914, p. 89 (Petra, Fairan, and Akaba, +) ; Parker, 1931, p. 514 (Fuzul, Qara Mountains and Dhufar, 3) ; idem, 1931 (a), p. 228, (*in. litt.*) ; idem, 1933, p. 397, (Qatarat in Rub-al-Khali, 1) ; idem, 1941, p. 5 (Jabal Harir, 1) ; idem, 1949, p. 70 (discussion of status and relationship of *P. sibilans* and *P. schokari*) ; Scortecci, 1932, p. 46 (Yaman, 1) ; Schmidt, 1939, p. 86, (Aden, 1) ; idem, 1953, p. 260 (Hodaida Ma'abar area and Ta'izz in Yaman, 4) ; Schmidt & Marx, 1956, p. 36 (Wadi Fairan in Sinai, 1) ; Haas, 1957, p. 47 (Qatif, Dhahran, Hail, Qara Mountains, 4) ; Haas & Battersby, 1959, p. 202 (Jol, 1).

Records. In addition to the localities given above, the senior author collected specimens from Buraiman, Sana, Kamaran Island, Jaar, Makhzan, Bir Ali, Mukalla, Tarim, and Dhufar.

Scale count. The scale count of the Arabian examples that have been recorded in the literature are Sc. 17, V. 170-196, C. 109-152. Those taken from the specimens in the senior author's collection fell within the above range.

Coloration. In all specimens a light brown, black-bordered line extends from the rostral, through the pre-ocular and post-ocular shields to the neck. In one form this line continues down the side of the snake to the end of the tail, a narrow white line separating it from the broad, grey-brown, black-edged dorsal stripe. The ventrals are white. In the other form the line fades at the neck, the dorsum being darker than the venter.

Vernacular names. The specific name *schokari*, given to the snake in the Yaman by Forskål was derived from *shigari*, ' of the tree '. This was heard by the senior author in Kamaran Island, applied by the police to a specimen killed in a tree. They said the name was used in the Yaman of the same snake. Parker (1931a, p. 228) records that in the Qara Mountains or Dhufar, the Shahari name for the snake is *ishor* and *inshor*. In the Aden Protectorate the unstriped form would be called *zarraq*, *tarrad*, or *al ahmar*=' the red one '. Several names have been applied to the striped form, *ba sharak*=' with grooves ', *mukhatat*=' line ', *ba sharatain*=' with two stripes ', and *abu khatain*=' of two lines ' ; the last is also used of the snake in the Trucial States. Because of the suggestion of palm fibre, *zaf*, it is also called in the Protectorate *zaf*, *zafi*, and *zaffan*=' palm fibre ' ' of the palm fibre ' and ' palm-fibred ' respectively.

Habitat. Specimens were taken in a house, on a sandy beach, under a tree near a building, and from a tree adjoining a well.

Rhynchocalamus arabicus Schmidt

Rhynchocalamus arabicus Schmidt, 1933, p. 9 (Aden, 1) ; idem, 1939, p. 49, (presumed *in litt.*).

Scale count. The scale count was Sc. 15, V. 240, C. 81, A. 2. The last 5 subcaudals were entire.

Rhynchocalamus melanocephalus (Jan)

Oligodon melanocephalus, Hart, 1891, p. 209 (Wadi Arabah, 1) ; Boulenger, 1894, p. 246, (*in litt.*) ; Anderson, 1896, pp. 82, 87, 90, (*in litt.*) ; idem, 1898, p. 277, (*in litt.*).

Rhynchocalamus melanocephalus, Barbour, 1914, p. 89 (Petra, 1).

Scale count. The scale count in Boulenger (loc. cit.) for Hart's Sinai specimen was Sc. 15, V. 229, C. 59, A. 2.

Spalerosophis diadema cliffordi (Schlegel)

Zamenis cliffordi, Günther, 1878, p. 978 (Tihamat, Midian, 1).

Zamenis diadema, Boulenger, 1887, p. 20 (Muscat area, 3) ; idem, 1893, p. 412, (*in litt.*) ; Hart, 1891, p. 209 (Mount Hor in Midian); Anderson, 1896, pp. 82, 86, 90, (*in litt.*, plus Hadhramaut, 2) ; idem, 1898, p. 269, (*in litt.*).

Spalerosophis diadema, Parker, 1931, p. 514 (Salalah, 1) ; idem, 1931a, p. 228, (*in litt.*) ; idem, 1938, p. 481 (S. Hajaz, 1) ; idem, 1941, p. 4 (Sana, 1) ; Schmidt, 1941, p.165 (Hulaifa in Najd, and Jiddah, 2) ; Schmidt & Marx, 1956, p. 33 (St. Catherine's Monastery and Fairan Oasis in Sinai, 2) ; Marx, 1959, p. 350 (*in litt.* and adoption of trinomials).

Records. Examples of this species were collected by the senior author from Buraiman, Abha, Shaik Uthman, Kod, Makhzan, and Jaar in the Abyan region, Baihan, Ahwar, Jol Bahawa, Mukalla, Dis, and Shihr.

Scale count. The scale counts for the Arabian specimens were Sc. 25-29, V. 211-240, C. 65-80, and the specimens in the senior author's collection have scale counts within the ranges given.

Coloration. The dorsal surface in life may be green, grey, or brown varying with the locality and with darker heavily defined circular or rhombic blotches themselves with paler edging. The ventral surface is white or straw-coloured.

Vernacular names. As *Spalerosophis diadema* is a relatively large and common snake with prominent markings, it attracts especially applicable names, and is probably the snake most commonly called throughout the Arab world, *al raqta*=' the spotted '. Parker (1931a, p. 228) records the Shahari name from the Qara Mountains and Dhufar as *fe'e de'e.* In Abha it was called *bu bilsain*=' of the lentils ', and in the Hajr Province in the Qu'aiti State, *al musabih*=' the rosaried '. *Rabudh*= ' spotted ' is also used in the Aden Protectorate.

Habitat. Specimens were taken in a brick store and from the gardens of houses. One was found in a lucerne patch near a water channel.

Remarks. A half-grown specimen was sent in from Baihan with a report that it had bitten a man who developed, among other symptoms, a transient haematuria. In view of its identity as a known harmless species it was suggested that there must be some mistake and further inquiries were made. It then transpired that the snake was brought in later than the case itself, after interest in the type of snake responsible for the bite was shown by the doctor. It seems most probable that the relatives then sought for a spotted snake in the neighbourhood of the accident and in good faith brought in the first such that was found. They had killed a *Spalerosophis*, whereas the actual biter was almost certainly an *Echis* or a *Cerastes*, both of which occur in the area, most probably an *Echis carinata*, since haemorrhage is characteristic of poisoning by this species.

***Telescopus dhara** (Forskål)

Tarbophis dhara Forskål, 1775, p. 14 (Yaman, 1) ; Anderson, 1896, pp. 62, 87, 89 (Medina, 1).

Dispsas obtusa, Boulenger, 1887, p. 407 (Muscat, 2).

Tarbophis guentheri, Anderson, 1895, p. 656 (Lahaj, 2) ; idem, 1896, pp. 52, 87, 88 (Hadhramaut, 2) ; idem, 1898, p. 287, (*in litt.*) ; idem, 1901, p. 137 (Abyan, 1) ; Boulenger, 1896, p. 52, (*in litt.*) ; Scortecci, 1932, p. 39 (Yaman, +) ; Parker, 1933, p. 398 (Hajaz, 1) ; idem, 1938, p. 481 (S. Hajaz, 1) ; idem, 1941, p. 4 (Jabal Jihaf, 1) ; idem, 1949, p. 87, (taxonomy discussed) ; Schmidt, 1939, p. 85 (Aden, 1).

Tarbophis obtusus, Anderson, 1898, p. 286, (*in litt.*).

Tarbophis dhara guentheri, Haas & Battersby, 1959, p. 202 (Saiun, 1).

Records. The specimens collected by the senior author were from Buraiman near Jiddah, Aden Town, Mukalla, Harshiyat and near-by Dis, Shihr, and Dis al Sharquiya.

Scale count. The scale counts recorded for the Arabian specimens are Sc. 19-23, V. 226-274, C. 53-82, A. variable. The specimens in the senior author's collection had scale counts within this range.

Vernacular names. The snake is not conspicuous, and is not likely to attract folk interest. The names applied to it in the Aden Territory would be those meaning snake in the general sense, that is *haiya*, *hanash*, *tarrad*, *zarraq*, and perhaps *al ahmar*=' the red ' as red and brown are not always differentiated colloquially.

Habitat. The snake is frequently found in buildings. Specimens have been found in a hole in a wall, in house gardens, in a heap of building debris, and from a drainage pool adjoining a mosque.

Diet. This snake and the species related to it have been noted as predators on small birds in Egypt by Anderson (1898, p. 284), and in the Sudan by Corkill (1935, p. 19). In Arabia, two of Anderson's specimens, found in a hole in a wall (1895, p. 656) had birds in the stomach contents. Of the present collection one was taken from a bird's nest in a school, and one from a garden had an escaped budgerigar in its belly. These snakes are frequently found in buildings which commonly harbour sparrows.

***Telescopus hoogstraali** Schmidt & Marx

Telescopus hoogstraali Schmidt & Marx, 1956, p. 33 (Wadi al Shaikh in Sinai, 2).

Scale count. The scale counts were Sc. 19, V. 214-216, C. 51-59, A. 2.

ELAPIDAE

The family is represented in the Peninsula by two genera, *Naja* and *Walterinnesia.* For the former there has been specifically established by Scortecci (1932, p. 47) *Naja haje arabica*, and it seems probable that this will be valid for all *Naja* in the Peninsula though there are various colour forms. All specimens of *Naja* seen by the senior author have had two suboculars, a characteristic of *Naja haje.*

Dickson (1949, p. 470) writes of two types of ' cobra ' in Kuwait and the Northern Hasa. He killed two at Araifjan which had hoods and were 42 inches and 48 inches long. Confusion with *Malpolon moilensis* is conceivable if it should prove that the latter in this area erects a hood, but the lengths are rather extreme. The local name is given as *hanish.* These are probably *Naja haje arabica.* He also writes of a black cobra, known as *ham* and *iyah.* This is probably *Walterinnesia aegyptia* which has been shown by Marx (1953, p. 189) to be synonymous with *Naja morgani* of farther north and north-east in SW. Asia. On a recent visit by the senior author to Abu Dhabi in the Trucial States, a snake, ' *haiya um al ghul* '=' demon snake ', was described as ' large, brown, a killer, and as inflating its throat '. A cobra was certainly the inspiration.

Naja haje arabica Scortecci

Naja haje, Anderson, 1898, p. 316 (Madina, 1).

Naja haje arabica Scortecci, 1932, p. 47, (Sana, +); Parker, 1931, p. 514 (Qara Mountains and Dhufar, +); idem, 1931 (a), p. 228, (*in litt.*); idem, 1938, p. 481 (Najran, 1); idem, 1941, p. 5 (Jabal Jihaf, 2); Haas, 1957, p. 81 (Jabal Qara, 1).

Records. The present collection contained specimens, from Abha in the Asir, Sana in the Yaman, Abyan, Musaimir (Haushabi), Mukairas, Wadi Duan, Khoraiba, and Dis in the Aden Protectorate and Khirba Wadi Urf, and Manawara in the Mukalla area.

Scale count. Anderson's female specimen from Madina (1898, p. 316) had counts of Sc. 21-23, V. 213, C. 54 approximating more to the Egyptian form of *N. haje* than to the records for *N. haje arabica* the published range for which is Sc. 19-21, V. 210-226, C. 62-80. Three of the author's present collection examined in the British Museum were within these latter limits.

Coloration. Several colour varieties were seen. The commonest was pinkish brown with darker head and tail, and variable dark blotching on the venter. In some the head and tail were black, and in some the dorsal scales were edged with black. There were also specimens of a uniform yellowish brown, darker on the dorsal surface. Some had a white tip to the tail.

Vernacular names. Parker records the Shahari names from Jabal Qara as *haut* and *defen*, and *ojem* for the young. A much travelled British executive from the gold mine in Mahad in Saudi Arabia informed the senior author that cobras were generally called *thi'aban* and were well known in Taif, Mahad, Rimah, Najd, the Yaman, and Kuwait. In the senior author's collection, the specimen from Abha was called *jozari*= 'spring'. In the Aden Protectorate specimens were called *harsh*=' gnawer' and *ham*. These names, however, are there given to any large snake. *Harsh al shams*=' *harsh* of the sun', *maharaqi al tarafain*=' of the two burnt extremities' and its variants, *maharaqi al asud*=' the black *maharaqi*' and lazily *maharaqi* and *tarafain*, are all names applied specifically to the cobra. Another name believed to apply specially to the cobra is *qura* =' bald'. The name *hanfish* is given to a snake that ' blows out its throat' and was applied to *Malpolon moilensis* (see above), but the cobra seems a more likely inspiration.

In the Trucial States it seems that *um al ghul* would apply to the Arabian cobra (see above). *Arathaid dharafu* is a Mahri name collected in Habarut and was said to be used of the cobra. A Marra tribesman inspecting a preserved specimen in the senior author's office said it was the snake that inflated its throat and was called in Marra, *yam*.

Habitat. Specimens mentioned above were collected in a ruined building in Abha, in a tin-smith's shop where another specimen had been killed three months before, in the dark in hilly country, and at night near a water-pump. One of a pair was killed in a palm garden near running water, one was found dead in a watercourse after flooding, and another was killed in, or adjoining, a well from which a stock of anti-malarial larvivorous fish had disappeared (see below). No specimens were taken in extreme desert conditions, all came from places near water or potential sources of water.

Diet. Although the local inhabitants blamed the cobra for the loss of the larvivorous fish mentioned above, an investigation of the stomach contents did not reveal any fish.

Remarks. Two lots of pairs were taken. No acceptable history of a bite by a cobra was encountered by the senior author in thirteen years of travel in the Peninsula. The non-black cobras described by Dickson (see above) from the Hasa were probably *N. haje arabica.*

Walterinnesia aegyptia Lataste

Walterinnesia aegyptia, Haas, 1957, p. 81 (Abqaiq, Dhahran, 3); Marx, 1953, p. 189 (believes it to be synonymous with *Naja morgani* Mocquard).

Scale count. The scale counts for the species, throughout its geographic range, are given by Marx (loc. cit.) as Sc. 21-23, V. 180-197, C. 40-53, A. 2. From 1 to 13 of the subcaudal scales are divided.

Vernacular names. The black cobras in the Hasa of which Dickson writes (see above) are very probably this species. They are known locally as *iyah.*

HYDROPHIDAE

No detailed records have been found for the presence of sea snakes in the Red Sea but Smith (1943, p. 477) writes that *Pelamis platurus* has been recorded from there and the senior author in 1949, while fishing in a creek at night at Khor Asfan, just north of Jiddah, saw a snake a few feet away swimming towards the boat. The accompanying fisherman said they were common and were attracted by lights such as that of the hurricane lamp which was being used to lure fish. Sea snakes are fairly common off the Aden Territory southern coast but the only one identified was a *P. platurus* picked up by the senior author, on the Khormaksar beach, near Aden. Sea snakes in the Aden Territory coast are commonly called *hanash al bahr*=' snake of the sea '.

In compiling the following records of sea snakes in the seas surrounding the Peninsula, Bombay has been taken as the southern coastal limit.

Astrotia stokesii (Gray)

Astrotia stokesii, Smith, 1926, p. 115 (Makran Coast and Karachi, 10), idem, 1943, p. 471, (*in litt.* +).

Scale count. The range of scale counts[1] recorded is Sc. 37-47, 47-59, V. 226-286.

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[1] The first two ranges relate to neck and widest part of body respectively.

Enhydrina schistosa (Daudin)

Enhydrina valakadien, Boulenger, 1896, p. 303 (Muscat and Karachi, 4).

Enhydrina schistosa, Smith, 1926, p. 39 (Muscat and Karachi, 6) presumably including the foregoing) ; idem, 1943, p. 449, (*in litt.* +) ; Corkill, 1932, p. 25, (Persian Gulf, 4) ; Volsøe, 1939, p. 9, (Gulf of Oman, 3).

Scale count. The range of scale counts recorded is Sc. 40-55, 49-66, V. 239-322.

Hydrophis cyanocinctus Daudin

Hydrophis cyanocinctus, Boulenger, 1896, p. 295 (Persian Gulf, Bushire, Khor Abdulla, Karachi, Muscat, Bombay, 8) ; Smith, 1926, p. 57, (including the foregoing, +); idem, 1943, p. 454 (*in litt.* +) ; Volsøe, 1939, p. 9 (Iranian Gulf, 7) ; Schmidt, 1939, p. 87 (Bahrain, 2) ; Haas, 1957, p. 82 (Al Khobar in Dhahran area, 10) ; idem, 1961, p. 21 (Dhahran area, 1).

Scale count. The range of scale counts recorded is Sc. 27-40, 37-47, V. 281-390.

Hydrophis fasciatus fasciatus (Schneider)

Hydrophis fasciatus, Smith, 1926, p. 95, quoting Wall (1921, p. 344) (Karachi, +).

Hydrophis fasciatus fasciatus, Smith, 1943, p. 465, (*in litt.*).

Scale count. The range of scale counts recorded is Sc. 28-33, 47-58, V. 414-514.

Hydrophis lapemoides (Gray)

Distira lapemidoides, Boulenger, 1896, p. 298 (Gwadar in Baluchistan, 1).

Hydrophis lapemoides, Smith, 1926, p. 88 (Persian Gulf, Jask, Makran Coast, 4) ; idem, 1943, p. 461, (*in litt.* +) ; Volsøe, 1939, p. 9 (Iranian Gulf and Gulf of Oman, 8).

Scale count. The range of scale counts recorded is Sc. 29-35, 43-51, V. 314-372.

Hydrophis mamillaris (Daudin)

Hydrophis mamillaris, Smith, 1926, p. 89, (Karachi and Bombay, 10) ; idem, 1943, p. 462, (*in litt.* +).

Scale count. The range of scale counts recorded is Sc. 25-29, 35-43, V. 302-390.

Hydrophis ornatus ornatus (Gray)

Hydrophis ornatus, Smith, 1926, p. 83 (Muscat and Bombay, 2) ; Volsøe, 1939, p. 9 (Shatt-al-Arab, 1).

Hydrophis ornatus ornatus, Smith, 1943, p. 460 (Persian Gulf, +).

Scale count. The range of recorded scale counts is Sc. 28-45, 33-55, V. 209-312.

Hydrophis spiralis spiralis (Shaw).

Hydrophis spiralis, Smith, 1926, p. 50 (Persian Gulf, Gangestum, Karachi, Muscat, 2) ; idem, 1943, p. 453, (*in litt.* +) ; VolsØe, 1939, p. 9 (Persian Gulf and Gulf of Oman, 4) ; Haas, 1961, p. 21 (Dhahran, 1).

Scale count. The range of scale counts recorded is Sc. 25-31, 33-38, V. 295-362.

Lapemis curtus (Shaw)

Lapemis curtus, Smith, 1926, p. 113 (Muscat, 1) ; idem, 1943, p. 470, (*in litt.* +) ; VolsØe, 1939, p. 9 (Persian Gulf, Straits of Hormuz and Gulf of Oman, 12).

Scale count. The range of recorded scale counts is Sc. 28-35, 33-43, V. 154-194.

Microcephalophis cantoris (Günther)

Microcephalophis cantoris, Smith, 1943, p. 475, (Karachi).

Scale count. The range of scale counts was Sc. 21-25, 41-48, V. 404, 468.

Microcephalophis gracilis (Shaw)

Hydrophis gracilis, Boulenger, 1896, p. 280 (Jask, 1).

Microcephalophis gracilis, Smith, 1926, p. 123 (Persian Gulf, Gulf of Oman, Makran Coast, Karachi, 6) ; idem, 1943, p. 472, (*in litt.* +) ; Corkill, 1932, p. 51 (Shatt-al-Arab, 1) ; VolsØe, 1939, p. 9, (Persian Gulf, 9).

Scale count. The range of scale counts recorded is Sc. 17-23, 29-43, V. 220-287.

Pelamis platurus (Linnaeus)

Hydrus platurus, Boulenger, 1896, p. 208 (Karachi, 1).

Pelamis platurus, Smith, 1926, p. 119 (Indian Seas, East African Coast, Bombay, 1) ; idem, 1943, p. 477, (*in litt.* plus ' Red Sea ').

Scale count. The range of scale counts is Sc. 49-67, V. 264-406.

Remarks. The senior author picked up a dead specimen on Khormaksar beach, Aden, in the early morning on a falling tide in 1956. It had a black dorsum and yellow venter.

Praescutata viperina (Schmidt)

Hydrophis jayakari, Boulenger, 1887, p. 408 (Muscat, 1).

Distira viperina, Boulenger, 1896, p. 299 (Bombay, 1).

Thallasophina viperina, Smith, 1926, p. 35 (Persian Gulf, 1) ; VolsØe, 1939, p. 9 (Gulf of Oman, 8).

Praescutata viperina, Smith, 1943, p. 448 (Persian Gulf, etc.).

Scale count. The scale range was, Sc. 27-43, 37-50, V. 226-274.

LEPTOTYPHLOPIDAE

These snakes are not commonly encountered in Arabia and of the species recorded, two are apparently restricted to Socotra. Like the family Typhlopidae, they are insignificant snakes and both forms would be spoken of as *dud*=' worm '.

Leptotyphlops spp.

Two specimens were collected by the Oxford University Expedition to Socotra in 1956 (Adho Dimellus and Kischen, 2).

Leptotyphlops burii (Boulenger)

Glauconia burii Boulenger, 1905, p. 178 (Al Kubar in Haushabi State, 1).

The species rests on one specimen only considered by Boulenger (loc. cit.) to be near *G. nursii.*

Measurements. The length/diameter ratio was 52, and the total/tail ratio 15⅔.

Leptotyphlops filiformis (Boulenger)

Glauconia filiformis Boulenger, 1899, p. 7 (Socotra, Dahamis, Jena-Agahan and Homhil, 4) ; idem, 1903, p. 88, (*in litt.*) ; Steindachner, 1903, p. 13 (Hakari in Socotra +).

Leptotyphlops filiformis, Parker, 1949, p. 20, (*in litt.*).

Measurements. The length/diameter ratio was 100-140.

Remarks. Records of the species are from Socotra only.

Leptotyphlops macrorhynchus (Jan)

Records. The species is new for Arabia, the previous range being Iraq, Iran, and Egypt. The present collection contained a single specimen from Aden Protectorate.

Measurements. The length/diameter ratio was 105.

Leptotyphlops macrura (Boulenger)

Glauconia longicauda (non Peters), Boulenger, 1899, p. 7 (Dahamis, Jena-Agahan, Homhil, Socotra, 8).

Glauconia macrura Boulenger, 1903, p. 89, (*in litt.*).

Leptotyphlops macrura, Parker, 1949, p. 20, (*in litt.*).

Records. Records of the species are from Socotra only. They were taken at altitudes of 350-2500 ft.

Measurements. The length/diameter ratio was 40-48 and the total/tail ratio 5-7.

Leptotyphlops nursii (Anderson)

Glauconia nursii Anderson, 1896, p. 64 (Aden, 2) ; Boulenger, 1896, p. 591, (*in litt.*)

Leptotyphlops yemenicus, Scortecci, 1933, p. 165 (Yaman, 1).

Leptotyphlops nursii, Parker, 1938, p. 481 (Najran, 2) ; Schmidt, 1953, p. 259 (Taizz, 5).

Records. The present collection contains three specimens from Mecca and the Aden Protectorate.

Measurements. The length/diameter ratio recorded is 50-51, the total/tail ratio 10-11½.

Habitat. The Taizz specimens were taken from a rubbish heap in the town. The Mecca specimen was collected in a house garden after dark.

Leptotyphlops phillipsi Barbour

Leptotyphlops phillipsi Barbour, 1914, pp. 87-88 (Petra in Sinai, 13).

Measurements. The length/diameter ratio was 86, the total/tail ratio 12½. The nostril does not reach the level of the eyes as in *L. macrorhynchus* and the second post-ocular labial is much larger than in the latter.

TYPHLOPIDAE

The snakes of this family like those of the Leptotyphlopidae would be simply called what they resemble, that is *dud*=' worm '.

Typhlops braminus (Daudin)

Typhlops braminus, Boulenger, 1893, p. 16 (Muscat, 1).

Measurements. The counts were Sc. 20 and the length/diameter ratio 35-55. The length is given as 175 mm.

Typhlops socotranus Boulenger

Typhlops sp., Günther, 1881, p. 462 (Socotra, 2).

Typhlops socotranus Boulenger, 1889, p. 362, (*in litt.*) ; idem, 1893, p. 21, (*in litt.*) ; idem, 1903, p. 88, (*in litt.* +, Dahamis, 1) ; Parker, 1949, p. 26 (*in litt.* and taxonomy).

Typhlops sokotranus, Steindachner, 1903, p. 13 (Socotra, +).

Records. Records are from Socotra only.

Measurements. The length/diameter ratio was 37-50. The tail was as long as broad. There were 26-28 scales round the body. Boulenger gives the length as 200 mm.

Typhlops vermicularis (Daudin)

Typhlops vermicularis, Duméril & Bibron, 1844, p. 303 (Sinai, +); Anderson, 1896, p. 81, (*in litt.*).

Measurements. The length/diameter ratio is given as 40-52 and the total/tail ratio 62.

VIPERIDAE

Eight species of vipers are recorded from the Peninsula, of which three are relatively common, *Cerastes cerastes*, *Echis carinata*, and *Echis colorata*, the last two being the commonest cause of accident and death from snake bite. Though deaths do occur, the fatality rate is thought to be low. Peripheral rarities in the north are *Pseudocerastes fieldii*, *Pseudocerastes persicus*, and *Atractaspis engaddensis*. *Vipera lebetina* recorded in the Yaman is a species that is normally found much further north and *Bitis arietans*, a typically African species, is recorded from the west and south, in hilly areas.

Certain of these snakes being fairly common and dangerously venomous, as might be expected, inspire the largest amount of folklore and the greatest number of folk names for snakes in the Peninsula.

In classical Arabic, viper is *afa*. Kopf (1960, p. 214) discusses the word and considers it fits particularly the *Echis* snakes and the horned viper (*Cerastes cerastes cerastes*). The word is discussed in relation to vipers in general above (p. 480). In the senior author's experience, from Libya to the Sudan and Aden, and through Arabia and Persia to Delhi, the word or its variants are applied more particularly to the *Echis* snakes, and seemingly are derived from the *f* sound, made by both the *Cerastes* and *Echis* when coiling about. At the same time, clear-cut difference in form, for example the presence of horns and excessive abundance, have not ruled out the use of many other colloquial names for certain vipers (see below), most notably, the *Cerastes* when horned, and the commoner, and thus more dominating, *E. carinata* of the two *Echis* species.

Atractaspis microlepidota andersoni Boulenger

Melanelaps mcphersoni, Wall, 1906, p. 27 ('Dhali'=Dhala?, N. of Aden +).

Atractaspis andersoni Boulenger, 1905, p. 178 (Al Kubar in Haushabi, 5); Parker, 1931, p. 514 (Aizet in Qara Mts. or Dhufar, 4); idem, 1931 a, p. 228, (*in litt.*); idem, 1949, p. 108 (discussion).

Atractaspis microlepidota andersoni, Laurent, 1950, p. 10 (revision of genus).

Records. In the present collection the specimens were collected from Kod in the Abyan area, one found preserved in a jar in Sheikh Uthman, and from unspecified localities in the western Protectorate. There is also a specimen in the British Museum, collected by Haythornwaite from Dhala.

Scale count. The range of scale counts is Sc. 23-25, V. 219-254, C. 27-33, A. 1. The specimens in the author's collection fell within this range. In two specimens from Kod, the tail terminates in a small white spike.

Vernacular names. Parker records the Shahari name as *disos*. The Kod specimens were referred to as *abu ashara daqiqa*=' of ten minutes ', presumably in relation to the interval between bite and death. This may have been brought to Kod by the Sudanese officials at the cotton ginnery, since both the name and the belief exist in the Sudan (Corkill 1935, p. 30) applied to *Atractaspis microlepidota*. The name *sul* was also used in both Kod and the Sudan and was heard later in Abu Dhabi in the Trucial States of a black snake said to be lethally poisonous.

Although only few specimens have been collected the snake is well known throughout the Aden Protectorate, where it is usually referred to as *al aswadi* or *al aswad*=' the black one '. In Mukairas the word *jahas* is used of it and in Mudia, *al munassi*=' the forgotten '. This last name is connected with the belief that the symptoms do not develop until three days after the bite, when it has been (*sic*) forgotten. In the Wahidi State the delay was said to be twenty-five to forty days. In Mahra at Habarut the snake was called *arathaid harut*=' snake black '.

Atractaspis engaddensis Haas

Atractaspis engaddensis, Schmidt & Marx, 1956, p. 36 (Fairan Oasis and Wadi, in Sinai, 2).

Scale count. Scale counts were Sc. 28-29, V. 275-282, C. 34-36, A.1.

Bitis arietans (Merrem)

Vipera arietans, Anderson, 1896, p. 55 (Hadhramaut, 1).
Bitis arietans, Boulenger, 1896, p. 494, (*in litt.*) ; Parker, 1931, p. 514 (Qara Mountains and Dhufar, In, Fazul and Sa'arin, 3) ; idem, 1931 a, p. 228, (*in litt.*) ; idem, 1941, p. 5 (Haz in Yaman, 1) ; Schmidt, 1953, p. 253 (Taizz, 2).

Records. The present collection contained two specimens, both from Sana in the Yaman.

Scale count. The recorded scale range for the Arabian specimens is Sc. 25-33, V. 126-138, C. 16-25, A. 1.

Vernacular names. Parker (1931a p. 228) records the Shahari name *dolalat* from the Qara Mountains and Dhufar. Scott (1947, p. 238) writes that in the Amiri highlands, the snake was called *haiya* and *hanash*, both general names for snakes. At Raidat Maarar in a Hadhramaut escarpment the senior author heard talk of a snake, ' a big killer in the hills ' called *tarsha*=' deaf one '. In the Sudan *Bitis arietans* shares the name *nawama*=' sleeper ' with *Python regius* because of their similar sluggish behaviour. In Iraq, *Vipera lebetina* is called the *haia tarsha*= ' deaf snake ', and in Cyprus, *kufi*, which also means ' deaf ', apparently because it seems sluggish. In parallel *B. arietans* may be the ' deaf snake ' of the Hadhramaut escarpment, from which in any case it has already been recorded.

Remarks. The species is characteristically African, and does not appear to be common in Southern Arabia. It is found discontinuously in the hills of the Yaman, Hadhramaut, and the Qara Mountains.

Cerastes cerastes (Linnaeus)

Vipera cerastes, Strauch, 1862, p. 359 (Arabah in Midian).
Cerastes cornutus, Werner, 1893, p. 359 (Sinai,+) ; Anderson, 1896, p. 82, (*in litt.*) ; idem, 1901, p. 151 (Abyan 1) ; Boulenger, 1896, p. 503 (Arabia, Sinai, Timaht in Midian, and Hadhramaut, 4) ; Barbour, 1914, p. 91 (Sinai, +). Parker, 1931, p. 514, (*in litt.*).
Aspis cerastes, Parker, 1938, p. 481 (South Hadjaz, 3) ; Schmidt, 1939, p. 88 (Al Jubail, 1) ; idem, 1941, p. 165 (Junaitha, 1) ; Haas, 1961, p. 19 (Al Hasa, 3) ; Haas & Battersby, 1959, p. 202 (Jabrin, 1).

Cerastes cerastes, Haas, 1957, p. 82 (Dhahran, Abqaiq, Shimal and Abu Shaiba in the oilfields, 23).

Records. Apart from the records mentioned above the species has been written of by various other authors. Doughty (1921, p. 313) writes of encountering it in his mid-nineteenth century travels in Midian, the Hejaz, and Najd. Thomas (1932, p. 59) writes of its being encountered in the Rub-al-Khali as 'inevitable'. Thesiger (1959, p. 108) writes of it as common in Atarit in the same desert. Dickson (1949, p. 470) writes of it in Kuwait and Hasa, Scott (1947, p. 25) says that it is plentiful in Shaik Uthman in Aden Territory. Philby (1939, p. 106) tells of encountering three one night at Shabwa in the Hadhramaut, and Abdullah Mansur (1911, p. 337) gives an account of them between Aden and Lahej.

The present collection numbers fourteen specimens of which five were horned. These came from Marrath Oasis in Saudi Arabia, Little Aden, Ahwar, Baihan, and the Thamud area on the edge of the Rub-al-Khali.

Scale count. The counts given in the literature for the Arabian specimens are Sc. 26-39, V. 139-166, C. 31-39.

Coloration. The ground colours in live specimens were yellowish, but preserved specimens ranged from yellow, through brown and pink, to grey. The specimen from Little Aden was much darker than the others.

Vernacular names. Doughty (1921, p. 313) gives the name of the species in north-west Arabia as *um janaib*,=' sideways one'. Thomas collected the name of *kabsh*=' ram' from the Rub-al-Khali, recorded by Parker (1931, p. 230, 1932, p. 344).

In Baihan, the snake was called *haiya* which, although frequently used of snakes in general, is most commonly applied to small, yellow, superficially similar forms, such as *Cerastes*, *Echis*, and *Eryx*. *Haiya biqurun*=' horned *haiya*' is the usual term in conversation. The name *kabsh* was used by a Manhali from Thamud. Other names used of this species were *haiyat al qurun*=' the *haiya* of the horns', *haiyat al jabal*=' the *haiya* of the hills or wilderness', *abu qurain*=' of two horns', and *um al qurun*=' of the horns'. At Habarut on the Mahra mainland, the corruption of the Arabic name is *rabudh biskarun*=' spotted one of the horns'. Because of its habit of occupying burrows or lying superficially buried, in sand, it shares the name *dafn* with *Echis* and *Eryx*. Specimens have also been labelled *bathan* (cf. Hebrew *pethen*)=' serpent' and *hanash al argat*=' the spotted *hanash*', which indicates some confusion with the last two genera.

Habitat. The snake is common throughout the sandy deserts of the Peninsula, and is also found in north Africa, Iraq and Iran.

Remarks. A boy was seen in Baihan playing fearlessly with large horned and unhorned specimens, and two small horned ones, one of which he teased until it bit a piece of rag.

Echis carinata pyramidum (Geoffroy St. Hilaire)

Echis carinatus, Günther, 1878, p. 977 (Midian, 1) ; Boulenger, 1887, p. 407 (Muscat, 7); idem, 1896, p. 506, (*in litt.*) ; Anderson, 1895, p. 635 (Lahej, 1) ; idem, 1896, p. 83 (Hadhramaut, 1) ; idem, 1898, p. 341, (*in litt.*) ; idem, 1901, p. 13 (Lahej, 1) ; Boettger, 1892, p. 63 (Aden, +) ; Parker, 1931, p. 514 (Zik in Qara Mountains or Dhufar, 1) ; idem, 1931a, p. 228, (*in litt.*) ; idem, 1949, p. 106, (discussion).

Echis carinata pyramidum, Constable, 1949, p. 156 (Snakes of Arabia referred to this sub-species).

Records. The senior author's collection included specimens taken from Buraiman, Lahej, Makhzan, Kod, Mukalla, Bagarain near Mukalla, Mola Matar, and Ghail Bawazir.

Scale count. The scale counts for the Arabian examples of this species are Sc. 27-32, V. 159-184, C. 27-48. A female specimen in the senior author's collection had a ventral count of 189 and mid-body scale count of 31. It was not possible to count the subcaudal scales, as the specimen was damaged.

Coloration. The dorsum may be grey or yellow to brownish or reddish with darker markings having paler edging, and with or without a paler marking suggestive of a broad arrow or bird's foot on the head. The effect of the paler markings is to suggest a wavy line down each flank. In a well-marked specimen the aptness of the name, ' carpet viper ', is clear. The belly may be clear white or tinged yellow, or may be speckled black or brown. In some specimens markings may be insignificant.

Vernacular names. Echis carinata shares several folk names and folk attributes with *Echis colorata*, due to the great similarity between the two species. In Aden Territory, a common name applied to them both is *afa* with its variants, perhaps more frequently in the West. In the East *dhuffa*=' cow-pat ' is commoner, and refers to their appearance when coiled up and lying on the ground. The most commonly used name, however, is *dafn* =' burier '. This last is widely applied to the *Echis* snakes and inspires a local jingle, one version of which is :

idha ladagak al dafn
jahiz al ganna wa al kafn.

[If you are bitten by the *dafn*
Prepare for Paradise and the shroud.]

The word *afa* has many variants, such as *fa, fai, fa'i, fau*, which may be regarded as partly mimetic in origin (see above, p. 480). Inspired by the rustle of the coils moving over one another, more definitely so are the names *fakhukh*, *fakhakk*, *fakhakha*, and *fashish*. These are more local in application, and together with the forms *um jahausha*, *majahausha*, (=*um jahausha*), and *warash* recall the mimetic colloquial names for *E. carinata* in the Sudan (Corkill 1935, p. 29), involving *f* and *sh* sounds.

In reference to the white wavy lines along the sides of the typical *E. carinata*, the classical name *dhu al tafitain*=' of the two festoons ', was heard once in 13 years. When the markings present are clearly defined as spots, the names *raqta*, *rabudh*, and *hanash arqat* all meaning ' spotted ' are used. In Jiddah specimens were called *um janaib* (a name used of *Cerastes* in Najd and Iraq), a Najdi giving the variant *um jannab.* A visiting Marra tribesman seeing a specimen in the office at Mukalla, said it was an *invaisha.* At Raidat Abdul Wadud, a local official said the *dhuffa* was also known as *jid al Saiban*=' the male ancestor of the Saiban '. The latter are a local tribe on the Hadhramaut escarpment. The name rather suggests a pre-Islamic cult vestige.

Habitat. The snake is usually found in rock, sand, gravel, and sparse xerophytic vegetation. Records of places in which specimens were taken include: near hospital buildings, near prison buildings, in a village, in a palace and other gardens, in cotton cultivation, and on a road in flooded ground.

Diet. A gerbille was found in the stomach of one of the specimens in the senior author's collection.

Remarks. In Ghail Bawazir, a small boy was seen handling the snake quite fearlessly. Two specimens responsible for non-fatal bites were brought in with patients, in Makhzan and Mukalla. The cases recovered but on the whole the lethality implied in the jingle (see above, p. 501), exaggerated though it is, is borne out by clinical experience. All serious cases of snake poisoning in the Territory for which there are acceptable records have had haemorrhagic symptoms characteristic of poisoning by this species. Occasional deaths undoubtedly occur.

Echis colorata Günther

Echis coloratus Günther, 1878, p. 988 (Jebal Sharr in Midian, 1) ; idem, 1881, p. 463 (Socotra, 1); Boulenger, 1887, p. 408 (Muscat, +) ; idem, 1896, p. 507, (*in litt.*) ; idem, 1903, p. 91 (discussion on Socotran record) ; Anderson, 1896, p. 83 (Hadhramaut, 1) ; idem, 1898, p. 343, (*in litt.*) ; Barbour, 1914, p. 90 (Akaba, 1) ; Parker, 1938, p. 481 (Hajaz, 1) ; idem, 1949, p. 105 (discussion on Socotran record) ; Dickson, 1949, p. 470 (Kuwait area, 2) ; Schmidt & Marx, 1956, p. 36 (Fairan Oasis and Al Raba in Sinai, 3) ; Haas & Battersby, 1959, p. 202 (northern Hadhramaut, 1).

Records. The present additions number 10 specimens from ' Aden Territory ', Little Aden, Jaar in the Abyan area, Jol Bahawa, and Fuwa, Khurba, and Riyan in the Mukalla area.

Scale count. The scale counts for the Arabian specimens were Sc. 31-35, V. 174-205, C. 44-54.

The two specimens in the senior author's collection that were not too mutilated to be accurately counted had scale counts within this range.

Vernacular names. This species is frequently confused with *E. carinata*, and it is not therefore surprising to find that apart from *dhu al tafiten* (inspired by a boldly marked *E.carinata*) the same names, already mentioned above, are used by the Arabs for both species.

As mentioned above the health assistant from Socotra, who was trained in Mukalla and who knew the snakes of both the island and the mainland, insisted that the *dhuffa*, the word used on the mainland of both *Echis* species, occurred in Socotra, and was there known as *diatib*. *E.colorata* has, in fact, but possibly erroneously, been recorded from the island (see above). He could not remember any serious cases of snake bite on the island, however, and none at all that had suffered from haematuria, a characteristic of viperine poisoning. Every other species recorded from the island is endemic, and it is possible that the snake is confused with the viper-like *Ditypophis vivax* (see above, p. 486). Unless another *Echis colorata* is found on the island, its occurrence there must remain doubtful.

Habitat. Of the specimens collected by the senior author, one came from under palm branches in a grass hut, one from water in a watercourse, and one from a mud hut.

Remarks. One bit a boy who, although up and about the next day, was said five months later to be still troubled with a swollen foot limiting complete freedom of movement.

Pseudocerastes fieldi Schmidt

Pseudocerastes fieldii Schmidt, 1930, p. 227 (Bair Wells and Um Wa'al in Jordan 1) ; idem, 1939, p. 88, (*in litt.*) ; Flower, 1930, p. 224 (South of Hassanat in Sinai, presumed *fieldii*, 1) ; Haas, 1957, p. 82 (Sakara near Jauf, 1).

Pseudocerastes persicus (Duméril & Bibron)

Pseudocerastes persicus, Laurent, 1948, p. 9 (Lingah, Persian Gulf, 1).

Scale count. The scale count was Sc. 25, C. 44.

Vipera lebetina (Linnaeus)

Vipera lebetina, Scortecci, 1932, p. 39 (Sana in Yaman, 1).

Scale count. The scale count was Sc. 23-27, V. 147-180, C. 29-51, A. 1.

Records. This is the southernmost record for the species, and rather remote from the normal distribution some 15° further north.

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Metrical and Non-metrical Variation in the Skulls of Gir Lions

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(*With three plates*)

INTRODUCTION

The story of the Indian lion has been told and retold in nearly as many ways as times, but with the exception of the papers by Pocock (1930, 1935), Dharmakumarsinhji & Wynter-Blyth (1951), Wynter-Blyth (1949, 1951, 1956), and Wynter-Blyth & Dharmakumarsinhji (1950) very little of value has been contributed to the topic. Even Pocock's admirable and very useful efforts were greatly hampered by a lack of evidence and material, for when his paper of 1930 was published the fragmentary remains of only a dozen or so Indian lions were available to him throughout the world. Furthermore, only three skulls which he was able to study represented wild-killed animals. This unfortunate situation has been corrected in part by subsequent collection of material and especially by the good fortune of recently obtaining a series of nearly complete skulls and mandibles representing 20 Gir lions. These skulls were ' found ' in November 1963, in a compound adjacent to the Forest Guest House at Sasan Gir. They had been gathered from the Sasan Range of the forest by shikaris over the preceding 5-10 years and allegedly were the remains of animals which had died natural deaths.[1]

Although this paper commences with a comparative study of Gir and African lions, it must be stated at the outset that this comparison is made only to demonstrate features characteristic of Gir lions which may then be studied within the Gir population. Beyond this there are serious theoretical objections attaching to the interpretations of an inter-population comparison. The principal objection revolves around the fact that the Gir population has been and still is subject to phenomena peculiar to small populations. Ordinarily differences which are found between two populations are attributed directly or indirectly to extrinsic factors on the assumption that both populations approach the classical Hardy-Weinberg model where the effects of inbreeding and chance are insignificant. The Gir population which apparently dwindled to about 25 animals around the turn of the century (Wynter-Blyth 1951) obviously does not conform to this ideal, thereby limiting or invalidating the usual interpretive procedures. A detailed intra-population study is under way, some aspects of which will be discussed below, but the main part of this undertaking will be presented in a future paper.

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[1] Some may have been dispatched by local herdsmen both by poisoning and in at least one instance by what might be reasonably interpreted as a gunshot wound. It was also mentioned by shikaris that some lions had drowned during the monsoon season in 1963. The condition of these specimens is tolerably good in spite of the fact that most of the canine teeth have been removed and the turbinals in most cases are missing. Some of the specimens show the results of having been molested by village dogs, which may also account for the missing mandibles.

METHODS

As a preliminary to the investigation of the Gir lion skulls, a sample of African skulls[1] was measured in order to generate, albeit somewhat arbitrary, a reference population. This reference population consists of a group of 31 skulls best described as '*P. leo*-African races'. More precisely it is comprised of the individuals indicated in Table I. All captive-born or raised animals, where known or suspected, have been rejected, as these have been shown to be greatly modified by captivity, especially as regards the skull (Hollister 1917). Only those specimens whose sex was recorded and a few which were unmistakably those of males or females because of size and age characteristics have been placed in one or the other category. In the unsexed group there are probably rather more females than males. The only fundamental objection to this group as a reference for the present purpose is that there appears to

TABLE I

SUBSPECIFIC AND SEX IDENTIFICATIONS (AS PER MUSEUM NOTES) OF THE REFERENCE POPULATION '*P. leo*-African races'

	Male		Female		?	
P. leo krugeri	8		2		3	
P. leo massaica	2		2		5	
P. leo nyanzae	2		2		1	
P. leo abyssiniae	0		1		0	
P. leo subspp.	2		1		0	
	14	+	8	+	9	=31

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[1] Specimens in the collection at the Museum of Comparative Zoology, Harvard University.

have been some preference for large size in assembling the Museum collection. This problem, however, has been taken into account as will be discussed in the analyses reported below. Table II gives the measurements of the sample '*P. leo*-African races' and Table III presents the same measures taken of 16 of the Gir skulls collected in 1963.[1] The measures made are only a portion of those which would ordinarily be employed in a 'classical' study, but they are more than sufficient for the various statistical analyses which have been performed. All measurements have been made to the nearest millimetre.

Discussion and Conclusions

Three analyses of the data from the measurements have been made. All were performed on the IBM 7049 computer, Computation Laboratory, Harvard University. The first, a component analysis[2] serves to indicate principal underlying components in the total variance of the sample and is a measure of redundancy in the measurements taken as a whole. The first principal underlying component explains approximately 95% of the total variance, and represents size almost assuredly as the ranking of individual specimens on this scale reveals. The second component, accounting for about 3% of the total variance, perfectly discriminates between the populations of '*P. leo*-African races' and '*P. leo*-Gir' and, therefore, may be thought of as a measure of 'African-ness' or 'Gir-ness' of these groups. The third component, accounting for about 2% of the variation in these samples, has not been attributed to any particular characteristic, and none of the remaining components clearly relate to sex, a fact which serves to increase confidence in comparisons of the two populations, as there might otherwise be reservations about the differences in sex ratios of the two groups.

The second analysis[3] examines the differences in the means of individual variables between the populations. The variables chosen for this analysis are the ratios of measurements to a standard length (condylobasal length), i.e. a series of indices. This manipulation effectively eliminates size as a variable. In Table IV the means for each variable and the

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[1] Measurements were made as follows: (1) Condylobasal length = basal length from anterior end of premaxillary to inferior notch between condyles; (2) Palatal length = length from anterior end of premaxillary to anterior end of posterior nasal opening; (3) Muzzle width = greatest width across muzzle at border of canine alveoli; (4) Intraorbital width = least width between superior border of orbits; (5) Postorbital constriction = least width; (6) Zygomatic width = greatest width across zygomatic arches; (7) Palatal width = width between inner roots of superior carnassials; (8) Mastoid width = greatest width across mastoid processes; (9) Condyle width = greatest width across condyles.

[2] BIMD 02—Component Analysis. BIMD Computer Programs Manual, Division of Biostatistics, School of Medicine, University of California, Los Angeles. 1961.

[3] Bossert, Wm. Analysis of Taxonomic Character Difference. Unpublished Manuscript. Department of Biology, Harvard University.

TABLE II

SKULL MEASUREMENTS OF ' *P. leo*-AFRICAN RACES '

Specimen number	5086	8052	9487	13273	13274	20976	21185	23024	23099	25545	27495	27496	28755	29785	31925	31926	31928	36280	36281	36282	36283	36284	36285	37654	37655	37656	37662	37751	37752	37753	46405
Condylobasal Length	251	282	307	243	291	253	253	291	252	235	282	268	241	312	239	231	231	318	245	282	312	316	315	273	307	319	301	307	311	267	(255)
Palatal Length	130	146	159	127	156	137	136	155	127	(124)	145	141	132	160	125	120	124	169	130	155	159	156	162	150	163	167	152	162	163	140	141
Muzzle Width	76	91	86	79	92	77	79	89	79	(78)	85	85	(78)	97	74	78	(75)	97	82	88	90	(95)	90	88	95	96	95	92	95	83	81
Intraorbital Width	61	69	65	58	64	57	61	69	58	55	65	64	58	72	56	50	45	78	57	69	70	73	74	64	80	74	70	70	74	60	59
Postorbital Constriction	64	60	60	60	57	56	65	63	60	57	58	65	60	62	58	56	58	70	64	70	62	68	64	63	64	73	68	63	63	61	60
Zygomatic Width	212	219	231	187	220	202	207	229	198	184	213	220	181	245	186	173	173	249	188	225	236	247	241	208	240	258	238	240	246	196	225
Palatal Width	71	(80)	(86)	74	78	70	79	84	74	(70)	78	82	67	87	72	68	(69)	86	73	83	81	84	89	82	89	91	81	87	86	75	78
Mastoid Width	114	133	132	112	134	114	115	136	116	113	135	127	115	138	117	108	111	146	111	130	136	142	137	128	140	147	134	133	140	118	(119)
Condyle Width	56	67	59	59	71	56	54	67	64	52	61	63	56	68	60	60	63	64	66	65	67	(68)	65	59	64	66	63	65	69	59	(59)

Bracketed figures represent values calculated from regression equation for respective condylobasal length (except specimen 46405 where condylobasal length and other dimensions were calculated from palatal length). A direct determination or reasonable estimate could not be made in these cases due to damage of the specimens. The calculated values were required for the computer programs employed in this study, the alternative being to reject the specimen and those measurements which were directly determined. See text for explanation of measurements.

TABLE III

SKULL MEASUREMENTS OF '*P. leo*-Gir'

Specimen number	1254	1255	1267	1268	1291	1292	1293	1329	1353	1363	1364	1389	1391	1392	1393	1396
Condylobasal Length ..	262	251	248	249	280	254	239	244	284	260	223	250	235	258	280	282
Palatal Length	130	127	123	124	142	128	121	123	143	127	115	128	118	135	142	141
Muzzle Width	86	82	80	80	91	81	77	77	92	85	73	83	79	86	91	91
Intraorbital Width	64	60	59	65	72	67	57	57	72	62	52	63	59	67	70	71
Postorbital Constriction ..	54	49	51	51	55	53	52	55	58	51	50	51	52	53	52	56
Zygomatic Width	202	195	197	202	232	204	188	197	226	195	(175)	201	190	205	215	235
Palatal Width	76	73	73	75	83	76	70	72	82	74	66	77	72	75	79	82
Mastoid Width	122	115	116	112	132	118	114	117	133	118	104	114	103	118	125	132
Condyle Width	56	53	51	50	56	(53)	51	51	58	57	52	53	46	54	56	56

NOTE. See Table II for explanations

distance (standard deviation) between the two means are presented. As a distance of 2·0 or two standard deviations indicates a significant difference at the 95% level, it can be seen at once that in no single index is there a significant difference. Statistically this means that there is nothing to explain and biologically it implies that the individual differences explain nothing. As a matter of interest, the same procedure was performed to compare independently both of the present lion populations to a series of measurements made on tiger skulls. Again, no significant differences between individual variables were found.

The third analytical procedure employed was a discriminant analysis.[1] Stated simply, this statistical manoeuvre reduces all the indices of all the specimens of the respective populations to two numerical values. These values are, in fact, the means of the distributions of the individual specimens which, similarly, may be represented by single numerical values. For each of the indices a coefficient of discriminant function is generated. This coefficient times the means for each of the indices of the respective populations gives the means of the populations, while the sum of the products of these coefficients times the indices of a given specimen yields a value representing the position of that specimen in the population distribution. According to the relationship of the two distributions to one another, conclusions regarding the significance of difference between the distributions can be made. In this particular case, the distance between the means of the two population distributions exceeds 2·0 standard deviations and there is no overlap between the distributions. The conclusion is, therefore, that in addition to being significantly different at the 95% level, a perfect discrimination can be made for individuals drawn from either of the populations compared on the basis of the measurements taken. Table V shows the distribution given by this analysis while Table IV gives the means, coefficients of discriminant function, products of these, and the per cent contribution to the difference between the population means for the eight products. While these latter calculations cannot be directly equated to the relative importance of the eight variables used in the discrimination, they do fairly draw attention to those which contribute most to the discriminating potential. This in turn stimulates curiosity as to the possible biological significance of the aggregate differences. Referring to Plate I, the regression lines for all measurements *v.* standard length have been plotted. Since the regression line for any two variables passes simultaneously through the means of the two variables, that point defines the mean ratio of the two variables. These mean ratios are, in fact, the indices which are employed in the discriminant analysis. However, it must be remembered that it is the

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[1] BIMD 05—Discriminant analysis-two groups. BIMD Computer Programs Manual, Division of Biostatistics, School of Medicine, University of California, Los Angeles. 1961.

TABLE IV

VALUES EMPLOYED IN ANALYSIS OF TAXONOMIC CHARACTER DIFFERENCE AND DISCRIMINANT ANALYSIS

	MEAN 1 ' *P. leo*-African races '	MEAN 2 ' *P. leo*-Gir '	Distance (Standard Deviations between the Means)	Coefficient of Discriminant Function (c)	Product Mean 1 × c	Product Mean 2 × c	Per cent Contribution to Difference
Palatal Length	·526	·504	·866	5·9896	3·1505	3·0187	·261
Muzzle Width	·311	·325	·637	–10·3582	–3·2214	–3·3664	·287
Intraorbital Width	·232	·248	·781	0·4016	·0932	·0996	–·012
Postorbital Constriction	·227	·206	·542	4·1771	·9482	·8605	·174
Zygomatic Width	·7835	·795	·322	–0·2655	–·2080	–·2111	·006
Palatal Width	·2866	·294	·289	–5·1509	–1·4767	–1·5144	·075
Mastoid Width	·459	·462	·083	–2·2362	–1·0264	–1·0331	·013
Condyle Width	·227	·208	·682	5·2076	1·1821	1·0832	·196
				Population means	–0·5585	–1·0630	1·000

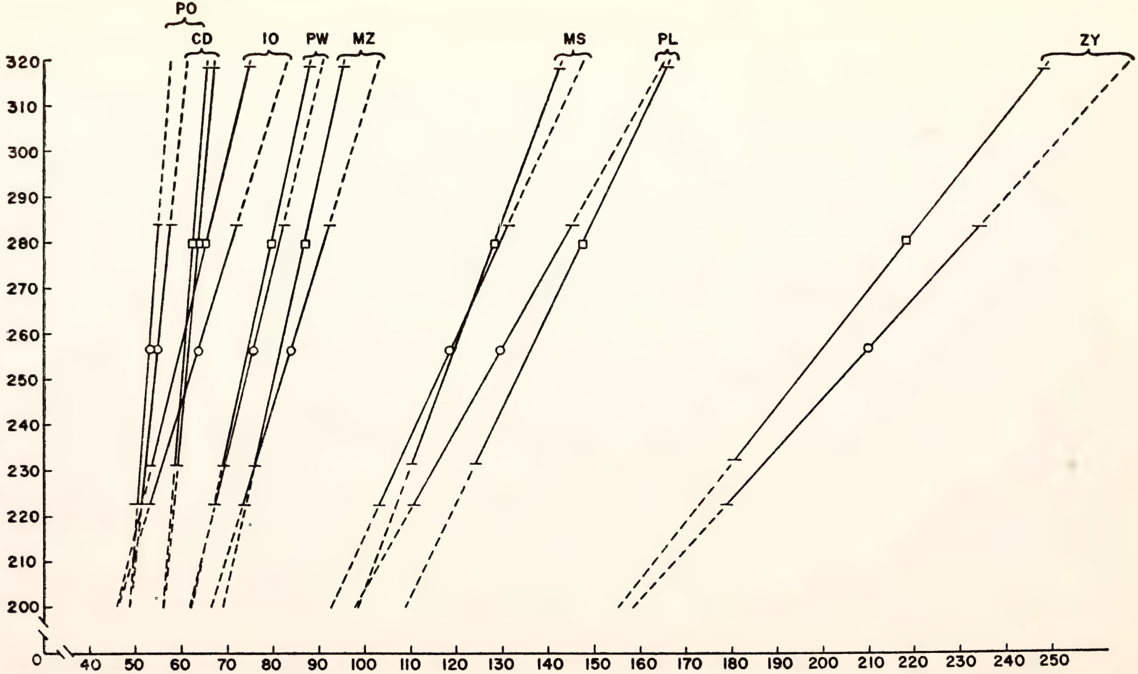
NOTE.—See text for discussion

distributions about these means and not the means themselves nor the regression lines which form the basis of the discrimination between populations. Hence the differences or similarities between any pair of regression lines cannot be taken as implying anything about significance, as shown by the second analysis. Nevertheless, as the aggregate

TABLE V

POPULATION DISTRIBUTIONS GIVEN BY DISCRIMINANT ANALYSIS

Rank	'*P. leo*-African Races'	'*P. leo*-Gir'	
1	−0·3635		
2	−0·3861		
3	−0·4066		
4	−0·4099		
5	−0·4125		
6	−0·4237		
7	−0·4528		
8	−0·4926		
9	−0·4978		
10	−0·5015		
11	−0·5124		
12	−0·5141		
13	−0·5200		
14	−0·5282		
15	−0·5380		
16	−0·5511		
17	−0·5688		
18	−0·5696		
19	−0·5697		
20	−0·5723		
21	−0·5907		
22	−0·6265		
23	−0·6545		
24	−0·6600		
25	−0·6623		
26	−0·6847		
27	−0·6945		
28	−0·7091		
29	−0·7249		
30	−0·7250		
31	−0·7474		
32		−0·8332	(BNHS 1364)
33		−0·9322	(BNHS 1329)
34		−0·9730	(BNHS 1293)
35		−0·9974	(BNHS 1392)
36		−1·014	(BNHS 1292)
37		−1·067	(BNHS 1393)
38		−1·067	(BNHS 1353)
39		−1·071	(BNHS 1255)
40		−1·084	(BNHS 1363)
41		−1·096	(BNHS 1254)
42		−1·112	(BNHS 1268)
43		−1·118	(BNHS 1267)
44		−1·134	(BNHS 1389)
45		−1·149	(BNHS 1396)
46		−1·165	(BNHS 1291)
47		−1·203	(BNHS 1391)



Regression lines of skull measurements *v.* standard length (in mm.) for *P. leo*-Gir (O) and *P. leo*-African races (□)
CD = condyle width; IO = intraorbital width; **MS** = mastoid width; MZ = muzzle width; PL = palatal length;
PW = palatal width; ZY = zygomatic width. **See text for discussion.**

differences are significant it is therefore profitable to look at the nature of the individual differences, especially those which contribute most to the discriminating potential. In comparing the skulls of the two populations a differentiation into a facial and cranial portion or neuraxial and non-neuraxial portion appears. The measurements indicate that the Gir lion tends to be broader but shorter in the facial or non-neuraxial region than the African lion, while in the cranial or neuraxial region this tendency is reversed. In Gir lions, the mastoid dimension shows an interesting pattern when compared to African animals. The smaller (and presumably younger) Gir specimens are relatively narrower in this measurement while larger specimens are relatively broader. It would appear that the mastoid width is determined by a neuraxial influence (brain size) in younger animals but in progressively more mature individuals, a non-neuraxial relationship becomes more pronounced as its development is increasingly influenced by musculature. These observations suggest that the determination of cranial capacities for the two populations might yield interesting results.

With regard to non-metrical and inter- and intra-population studies it is appropriate to consider the following facts at this time. Pocock (1930), in summarizing the differences between Indian and African lion skulls, mentions the flatness of the auditory bullae in the former. Among the present sample this distinction is readily apparent. Pocock's statement, ' but beyond question they [the bullae] are in almost all cases considerably more inflated in African skulls than in the Indian specimens I have seen ', is perfectly applicable to the present groups. A second feature which Pocock found remarkable about the Indian lion was the frequent division of the infraorbital foramen, either unilaterally or bilaterally, into upper and lower openings which were separated by a bridge of bone. In African lions such a situation is unknown. In Tables VI and VII are summarized the condition found in 15 skulls which date from 1822-1931 and in 19 specimens from the 1963 Sasan ' find '. Of the earlier 15 animals, a total of ten show this peculiarity. Whether significant or not, it is interesting to note that this trait was manifested in four out of five skulls recorded for the 19th century, while in ten skulls described between 1910-1931 it is present in six. Finally, among the most recent material, 1953-1963 approximately, a divided foramen is seen in only 5 out of 18½ (as one side of one specimen is missing and one skull is fragmentary) individuals. At the same time as the incidence of affected individuals appears to diminish, the extent of the affection also diminishes. If affected foramina rather than individuals are totalled the differences become much more striking (? and significant), i.e. 1822-1857, 7/10 or 70·0%, 1910-1931, 8/20 or 40·0%, 1953-1963, 6/37 or 16·2%. The temptation is great, even if not justified, to speculate that the condition and its expressivity and/or penetrance are under the influence

TABLE VI

THE CONDITION OF THE INFRAORBITAL FORAMINA IN INDIAN LIONS

	Date	Locality	Museum & No.	Condition of infraorbital foramina		Remarks
				Left	Right	
1	1822	North Gujarat	RCS 4484	Double	Triple	Destroyed in bombing—1941
2	1830	Assund	RCS 4485	Double	Normal	
3	*c.* 1833	?	———	Double	Double	Lost, see Pocock (1930) pp. 653, 657
4	*c.* 1833	?	———	Double	Double	
5	1857	Gir	BM 57.2.24.1	Normal	Normal	Died after *c.* 2 yrs. in captivity
6	*c.* 1910	Amerli	BM 30.6.6.1	Normal	Normal	See Pocock (1930) p. 657
7	*c.* 1910	Amerli	BM 30.6.6.2	Normal	Double	
8	*c.* 1910	Amerli	BM 30.6.6.3	Double	Normal	
9	1920	Gir	CMNH 31121	Double	Double	
10	1929	Gir	AMNH 54995	Normal	Normal	
11	1929	Gir	AMNH 54996	Double	Double	
12	1930	Gir	BNHS 5745	?	?	See Pocock (1930) ed. note p. 665 specimen of Col. Mosse—cannot trace
13	1930	Gir	———	Normal	Double	See Pocock (1930) p. 665 specimens of H. H. the Maharajah of Nawanagar—cannot trace
14	1930	Gir	———	Normal	Double	
15	1931	Gir	BNHS M5744	Normal	Normal	Shot by H.H. the Nawab of Junagadh see Pocock (1930) ed. note p. 665
16	*c.* 1931	Gir	BNHS M5926	Normal	Normal	Specimen presented to the Society by Col. Burton

NOTE.—AMNH—American Museum of Natural History; BNHS—Bombay Natural History Society; RCS—Royal College of Surgeons; BM—British Museum; CMNH—Chicago Museum Natural History.

of only a few polygenes which have shown considerable shifts in frequency over the past 140 years, possibly due to genetic drift. The pivot point or bottleneck for population size is around the turn of the century when the number of animals dwindled to about 25 and the effective breeding population might have been as low as half a dozen animals. Seven additional skulls not recorded in Table VI are in the collection of the British Museum. While dates of death are not ascertainable for most of these, six represent a time span from April 1865 to 1 January 1945. Among these six there are six divided and six normal foramina. This frequency of 50% is identical to the cumulative frequency for the 15 animals noted in Table VI for the time span 1822-1931. The seventh specimen which died in 1951 or 1952 has both infraorbital foramina normal. As the intra-population studies are pursued, both through extracting data from older material and through the collection on new material, these considerations will hopefully be clarified.

Table VII

The condition of the infraorbital foramina in lions of the 1963 Gir 'find'

	Date	Locality	Museum & No.	Condition of infra-orbital foramina Left	Right	Remarks
1	1953-1963	Gir	BNHS 1254	Normal	Double	
2			BNHS 1255	Normal	Normal	
3			BNHS 1261	Normal	—	Right side broken away
4			BNHS 1267	Normal	Normal	
5			BNHS 1268	Normal	Normal	
6			BNHS 1291	Normal	Normal	
7			BNHS 1292	Double	Normal	
8			BNHS 1293	Normal	Normal	
9			BNHS 1329	Normal	Double	
10			BNHS 1353	Normal	Normal	
11			BNHS 1363	Normal	Normal	
12			BNHS 1364	Normal	Normal	
13			BNHS 1389	Normal	Normal	
14			BNHS 1391	Normal	Double	
15			BNHS 1392	Normal	Normal	
16			BNHS 1393	Normal	Normal	
17			BNHS 1396	Normal	Normal	
18			BNHS —	Double	Double	Number not available
19			BNHS —	Normal	Normal	Number not available
20			BNHS —	—	—	A very broken skull, no number assigned

An additional feature characteristic of Gir lions as a group is the variability of the third lower premolar. This variation appears to have escaped notice in any literature to date. In the African lion Pm$\bar{3}$ is universally present with two well-developed, distinct roots. Table VIII tabulates the condition as found in the present sample and Plates II-III show X-rays of mandibles in which this tooth is lacking. The latter is interpreted as a demonstration that the apparent absence of this tooth is not due simply to a failure to erupt. In one specimen (BNHS 1364) the deciduous alveoli of one side are clearly present but there is no trace of a permanent replacement tooth. Furthermore, in all cases where Pm$\overline{3}$ is absent, the diastema created by the missing tooth appears porous with surface irregularities and occasionally there is tissue which appears grossly to be enamel although it is not organized into anything resembling a tooth. Tentatively, it is concluded that the deciduous Pm$\overline{3}$ is present and that no replacement tooth is produced. Twelve of the earlier specimens (American Museum of Natural History, 2 ; Bombay Natural History Society, 3 ; Chicago Museum of Natural History, 1 ; British Museum, 6) have this tooth bilaterally, while in three others (British Museum) there is unilateral reduction to a rudiment. The earliest of these latter is *c.* 1910, the other two prior to 1931. Unfortunately the

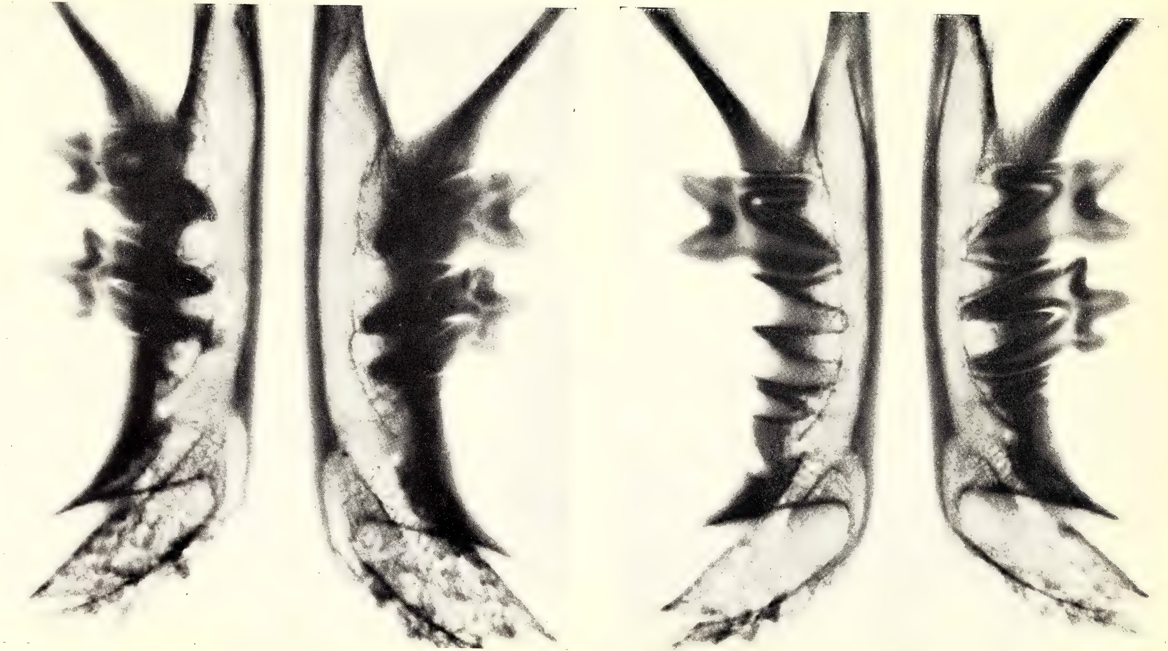
TABLE VIII

THE CONDITION OF PM$\overline{3}$ IN LIONS OF THE 1963 GIR 'FIND'

Museum & No.	Condition of Permanent Lower Third Premolar					
	Left			Right		
	2 roots	fused	absent	2 roots	fused	absent
BNHS 1254		75%			100%	
BNHS 1255			X			X
BNHS 1261	no left ramus				25%	
BNHS 1267	no mandible					
BNHS 1268	no mandible					
BNHS 1291		100%			100%	
BNHS 1292		100%		?	(tooth broken and abnormal—perhaps slight fusion)	
BNHS 1293	X			X		
BNHS 1329		100%		X		
BNHS 1353		90%			90%	
BNHS 1363		50%		no right ramus		
BNHS 1364			X			X
BNHS 1389			X			X
BNHS 1391		100%			100%	
BNHS 1392			X			X
BNHS 1393	no left ramus				90%	
BNHS 1396		100%			100%	
BNHS ——	X			X		
BNHS ——	deciduous teeth being replaced by permanent					
BHHS ——		90%			90%	

NOTE. X = as per column heading

PLATE II

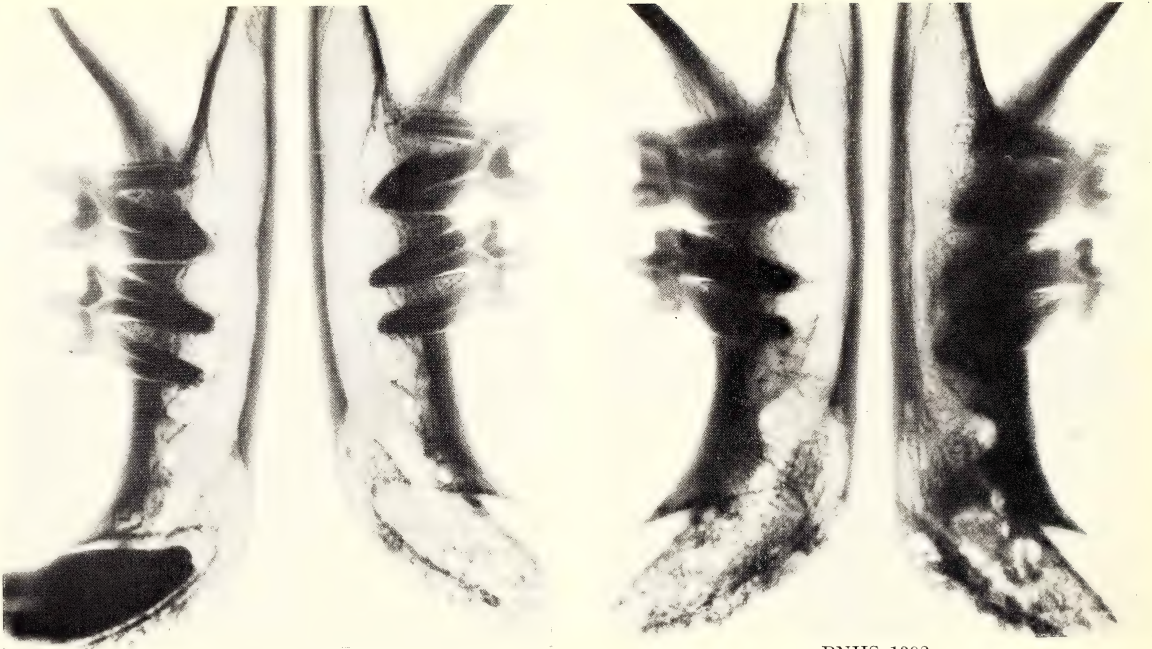


BNHS 1255

BNHS 1364

X-ray photographs of the mandibles of Gir lions showing the absence of $\mathrm{Pm}\bar{3}$

(*Photos : N. B. Todd*)



BNHS 1389 BNHS 1392

X-ray photographs of the mandibles of Gir lions showing the absence of Pm$\overline{3}$

(*Photos : N. B. Todd*)

four earliest known specimens (1822-1833) are no longer available, for two of them could not be traced by Pocock (1930) and two which were in the Museum of the Royal College of Surgeons, London, were destroyed in a bombing of 1941. It can only be presumed that the teeth were bilaterally present in these specimens as their absence would probably have been noted. It is more likely that the variation in the root condition of this tooth may have gone unnoticed by previous investigators. In the specimens thus far seen, a number have not been sufficiently investigated, as this will require X-ray in order to avoid damage. However, the Chicago Museum of Natural History specimen shows complete bilateral fusion of the roots as do a number of British Museum specimens. Finally, other dental anomalies, such as the fusion of roots of M$\overline{1}$ have been noted and will be reported at a later date.

In one form or another the question of the taxonomic position of the Gir lion is often posed. It would appear from the foregoing considerations, admittedly in need of further detailed study and elaboration, that this problem is imaginary. It would make as much sense to ask what is the taxonomic position of lions in zoological gardens in Europe and North America. One can only say that the taxonomic *status* of zoological specimens is peculiar and indeterminate. Similarly goes the argument for Gir lions. Nevertheless, the present Gir population and its ancestors and descendants offer an interesting situation in which small population phenomena may be profitably studied.

ACKNOWLEDGEMENTS

This investigation was supported in part by a Public Health Service Fellowship (No. 1-F2-MH-18,520-01) from The Institute of Mental Health, Public Health Service. Additional support was given by the Committee for the Study of Evolutionary Biology, Harvard University. The assistance and co-operation of the Forest Department of Gujarat State and the Bombay Natural History Society are gratefully acknowledged. To Dr. William Bossert, Computations Laboratory, Harvard University, go special thanks for the computer analyses and much valuable assistance.

SYNOPSIS

1. It is noted that inter-population studies of African and Gir lions are useful only as a means of detecting peculiarities of the latter. This arises from the fact that the Gir population has been and still is subject to small population phenomena.

2. No one of nine skull measurements made discriminates between African and Gir lions (or between either and tigers).

3. In a discriminant analysis, a significant and perfect discrimination was made between 31 African and 16 Gir lion skulls. This discrimination is equated roughly to the relatively shorter palatal, broader facial, and more constricted cranial proportions of the Gir lion.

4. In non-metrical characteristics, two features which are restricted to, although not universal among, Gir lions are noted. These are the division of the infraorbital foramen and the variation in development of the third lower premolar. The general decrease in frequency of foramina division over the last 140 years is suggested to be related to gene frequency shifts possibly resulting from genetic drift. The fusion of the roots of $Pm\bar{3}$ is noted to be a common trait in Gir lions, although not previously reported. The absence of this tooth appears for the first time in a skull of *c.* 1910 and appears to have increased in incidence among skulls of animals which died between approximately 1953-1963.

5. While the taxonomic position of the Gir lion is a meaningless concept, the population affords an interesting opportunity to study small population phenomena.

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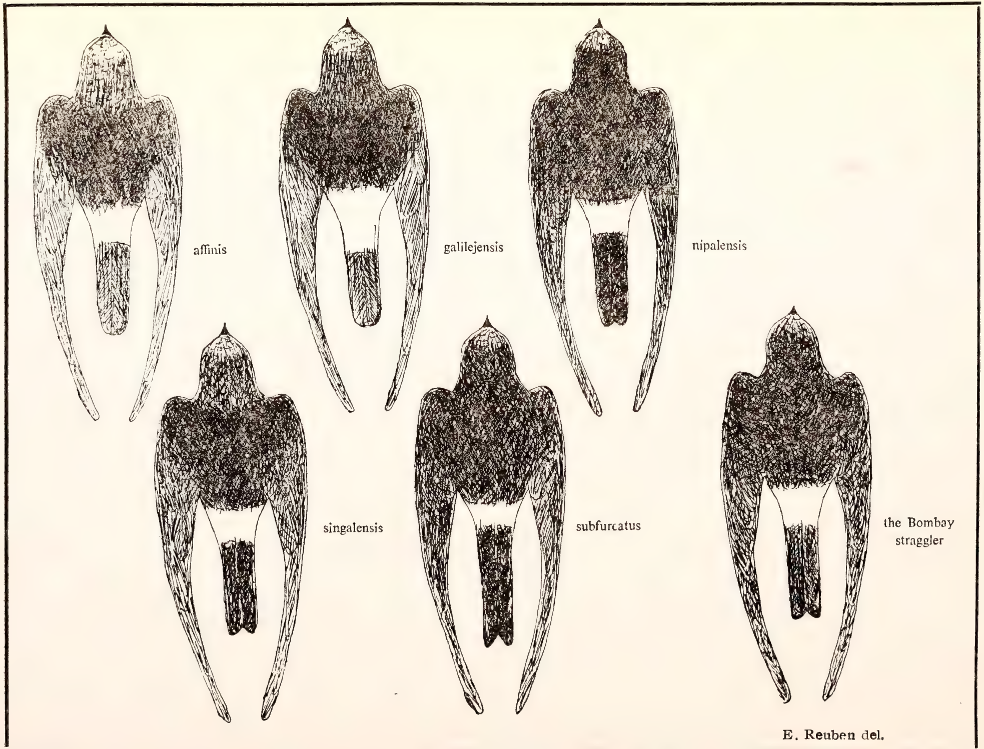
affinis
galilejensis
nipalensis
singalensis
subfurcatus
the Bombay straggler
E. Reuben del.

Sketch showing markings of races of *Apus affinis* (J. E. Gray) in India
(Diagrammatic)

Notes on Indian Birds 5— The races of *Apus affinis* (J. E. Gray) in the Indian Region

BY

HUMAYUN ABDULALI

(*With one plate*)

Stuart Baker (1927, FAUNA **4** : 332) accepted four races of the Common House Swift [*Apus affinis* (J. E. Gray)] from the Indian Region and drew attention to the Ceylon birds being very dark. The distribution of the races was however very unsatisfactorily indicated and led to much confusion among subsequent workers. Ripley (1961, SYNOPSIS : 210-211) accepted an additional form ' from Ceylon and possibly Kerala ', and remedied to a great extent the distributional limits of the other races.

Recently (1964, *J. Bombay nat. Hist. Soc.* **60** : 731) I referred to a swift (*A. affinis*) blown into Bombay on 11 November 1957, which I had been unable to name trinomially in Bombay. It was sent to the British Museum (Nat. Hist.) whence Mr. J. D. Macdonald wrote :

' *Sp. No.* 20056 *Apus affinis :* We are unable to determine with certainty the race to which this specimen belongs. In size it agrees most nearly with *subfurcatus* of which we have specimen wings 140 and 141 mm. But it is paler than our specimens of this race and agrees best in tone of colour with specimens of *nipalensis*. It very nearly matches typical *affinis* except for slightly darker wings and larger size.'

I have subsequently been able to get together and/or examine some 120 specimens and, though the straggler into Bombay does not fit clearly into any named group, the general results of the inquiry appear to be worth recording.

The measurements of the different subspecies or groups referred to are incorporated in the table below and the accompanying sketch illustrates the differences in markings between the races referred to in this note. Supplementary remarks are included under each subspecies.

affinis (J. E. Gray, 1832) (Ganges, restricted to Cawnpore by Stuart Baker)

Races *affinis* and *galilejensis* are separable from the other races by the upper surface of the tail being appreciably paler than the back. They have also no fork in the tail.

The picture of *affinis* in ILLUSTRATIONS OF INDIAN ZOOLOGY, which forms the original description, shows a distinctly pale head and forehead and no intense black on the back, but the drawing does not appear accurate enough to warrant a subspecific identification thereon. The type locality was restricted to Cawnpore by Stuart Baker (loc. cit.), a fact that is overlooked in the SYNOPSIS. In the Indian specimens available, there is some variation in the intensity of body colour and the amount of grey on the forehead. In most, there is a thin whitish eyebrow but it is often necessary to ruffle the feathers to make it visible. There is a slight decline in size from the Punjab in the north to Cuddapah in the south whence the southernmost specimens are available.

A series of 9 from Mitauri and Hyderabad (Sind), about 80 miles east of Karachi, agrees with these birds and in size forms a part of the cline referred to. The white of the rump is wider[1] (av. 14 mm.) than in the Punjab birds (av. 11·6 mm.) which though slightly larger than those from the south do not appear to show any difference from them in this character. Birds from Calcutta appear to be nearer in this respect to those from Hyderabad (Sind) than to those from the Punjab.

Race *abessynicus* (Streubel) (Massawa) is said to be identical with *affinis* and the one specimen which I have seen from Yemen (Arabia) shows no character which would separate it from Indian birds.

The form occurring in south-west India has still to be determined, though it is believed to be *singalensis*.

galilejensis (Antinori, 1855) (Sea of Galilee)

Ticehurst in ' Birds of Sind ' (*Ibis* 1923, p. 36) identified the birds from Karachi as *galilejensis*, though he said they were a little smaller (wings 131-134 against 132-137) ; but Whistler & Kinnear (1935, *J. Bombay nat. Hist. Soc.* **38** : 31), comparing the Punjab birds with those from south India, said that there was no point in recognising them as separate and recommended the removal of *galilejensis* from the Indian list. This was probably due to their assuming that the Karachi birds would be the same as those from further north and eastwards in peninsular India.

Fifteen specimens from Karachi and one from the Mekran Coast can be distinguished from *affinis* by the much more prominent ashy white on the forehead and the wider patch of white (av. 14·4 mm.) on the rump. This last character is retained in the series of 9 birds from Hyderabad (Sind) (*supra*) and reappears in 11 adults taken at Calcutta. It is curious that it should not be apparent in a north-south cline.

The Karachi birds have been accepted as *galilejensis*, but they differ from the few topo-typical and other non-Indian Middle East specimens of *galilejensis* available for examination in that the white on the forehead, which varies in extent but is distinctive in most, is formed by white-tipped feathers creating a very distinct scaly appearance that does not show in the others—some indeed are almost indistinguishable from *affinis*. This character appears in a single specimen from Mt. Abu (Rajasthan), but a nestling obtained at the same time and place does not differ from another of the same age from Bombay.

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[1] Throughout this paper the 'width' of the white patch is measured from front to rear along the middle of the body.

In *affinis* the black central feathers of the back are longer and mask the white of the rump in the centre leaving it on an average about 11 to 12 mm. wide against 14 to 15 mm. in *galilejensis*.

The white eyebrow is more pronounced than in *affinis*.

singalensis Madarász, 1911 (Ceylon)

The head and tail are darker than in *affinis*, the tail being only slightly paler than the back. In *nipalensis* and *subfurcatus* the tail is as dark as the back. The Ceylon birds differ from *nipalensis* in having more gloss on the head and are very similar to *subfurcatus* except for the shorter tail (44·6 mm.), more white on the rump (12 mm.), and the less distinctly forked tail. The white feathers of the chin and rump have dark shafts more often than in Indian birds, another character shared with *subfurcatus*.

Whistler & Kinnear (1935, loc. cit.) said that two specimens from Travancore agreed with the Ceylon birds rather than with *affinis* and this is possibly the basis of Ripley's statement quoted earlier.

nipalensis (Hodgson, 1836) (Central region of Nepal, restricted to Khatmandu by Biswas)

It was described as ' sooty black glossed with green ' with no other characters mentioned to distinguish it from *affinis*. Stuart Baker (loc. cit. : 332) said that it differed from *affinis* in having the crown and forehead all brown against grey, not white, in *affinis*. He added that it was a much darker bird than *affinis* and *galilejensis* and he extended its range southwards to Mysore, Travancore, and Cochin. The form in the south-west has yet to be identified but, even if it is found to be similar to *nipalensis*, the distribution is certainly broken in peninsular India, which is occupied by *affinis*. The description is generally correct, but in some of the specimens from Nepal (which include old specimens labelled *subfurcatus*) the back is dark brownish and does not show the green gloss mentioned in the original description. Three specimens from the British Museum (Nat. Hist.) have dark glossy backs and brown heads, indicating that the specimens retained in India have either faded and lost this colour or they represent a juvenile plumage of a nature which does not show itself in *galilejensis* or *affinis*.

TABLE OF MEASUREMENTS (in mm.) OF RACES OF *Apus affinis*

No. of specimens	Particulars of specimens	Wing	Tail	White on rump (measured along middle of body)
	affinis			
6	Punjab, Delhi (1) ..	130-135 av. 132·5	40-43 av. 41·6	11-13 av. 11·6
18	Rajasthan, Gujarat, Kutch, Bombay, Indore, Cuddapah, Darbhanga ..	123-132 av. 127·5	37-43 av. 40·2	8-15 av. 11·3
6	Juveniles (only two measured) ..	85, 63	39, 38	——
17	Calcutta ..	124-132 av. 129 (7 measured)	38-44 av. 41 (15 measured)	12-17 av. 14·5 (11 measured)
9	Mitauri and Hyderabad (Sind) ..	123-132 av. 129·8	39-44 av. 41·5	13-16 av. 14
	galilejensis			
10	Palestine, Middle East, Shiraz (1) ..	130-135 av. 132·5	40·5-45 av. 42·4	12-17 av. 14·7
16	Karachi (several in moult) and Mekran (1) ..	123-132 av. 127	39-42 av. 40·6	12-17 av. 14·4
	singalensis			
6	Ceylon ..	127-130 av. 129·3	43-45 av. 44·6	10-13 av. 12

	subfurcatus			
3	Pahang (2), Malacca ..	135 ♀ - 140 ♂ av. 137·5	49-54 av. 51·3	6 (Pahang)-12 (Malacca) av. 8
4	Inner Gulf of Siam ..	125 ♀ - 130 ♂ av. 127	48-53 av. 50·5	8-13 av. 11·4
	nipalensis			
6	Khatmandu, Nepal ..	128-137 av. 132·3	42-46 av. 44	10-13 av. 12·4
16	Nepal (see Biswas, 1961, *J. Bombay nat. Hist. Soc.* **58** : 119) ..	132-138 av. 133 (one with 118 mm. wing is excluded)	42-49 av. 45	?
	Race/Races uncertain			
3	Kurseong (2), Terai (possibly *nipalensis*) ..	128-135 av. 131	41-43 av. 42	8-10 (tails appear tucked in)
1	Darjeeling, ♂ with gloss on head ..	133	44	15
4	Migrants (?) to Samastipur (Darbhanga), Chanda (Maharashtra), and Kendrapara (Orissa) (2) ..	132-139 av. 135	46-49 av. 47·7	11-13 av. 12
1	Haflong, North Cachar ..	135	48	12
1	Bombay (straggler) ..	143	48	9

NOTE.—As there appears to be no difference in size between the sexes, the limited number of measurements are tabulated together.

TABLE OF MEASUREMENTS (in mm.) OF RACES OF *Apus affinis*

No. of specimens	Particulars of specimens	Wing	Tail	White on rump (measured along middle of body)
	affinis			
6	Punjab, Delhi (1) ..	130-135 av. 132·5	40-43 av. 41·6	11-13 av. 11·6
18	Rajasthan, Gujarat, Kutch, Bombay, Indore, Cuddapah, Darbhanga ..	123-132 av. 127·5	37-43 av. 40·2	8-15 av. 11·3
6	Juveniles (only two measured) ..	85, 63	39, 38	——
17	Calcutta ..	124-132 av. 129 (7 measured)	38-44 av. 41 (15 measured)	12-17 av. 14·5 (11 measured)
9	Mitauri and Hyderabad (Sind) ..	123-132 av. 129·8	39-44 av. 41·5	13-16 av. 14
	galilejensis			
10	Palestine, Middle East, Shiraz (1) ..	130-135 av. 132·5	40·5-45 av. 42·4	12-17 av. 14·7
16	Karachi (several in moult) and Mekran (1) ..	123-132 av. 127	39-42 av. 40·6	12-17 av. 14·4
	singalensis			
6	Ceylon ..	127-130 av. 129·3	43-45 av. 44·6	10-13 av. 12
	subfurcatus			
3	Pahang (2), Malacca ..	135 ♀ - 140 ♂ av. 137·5	49-54 av. 51·3	6 (Pahang)-12 (Malacca) av. 8
4	Inner Gulf of Siam ..	125 ♀ - 130 ♂ av. 127	48-53 av. 50·5	8-13 av. 11·4
	nipalensis			
6	Khatmandu, Nepal ..	128-137 av. 132·3	42-46 av. 44	10-13 av. 12·4
16	Nepal (see Biswas, 1961, *J. Bombay nat. Hist. Soc.* **58** : 119) ..	132-138 av. 133 (one with 118 mm. wing is excluded)	42-49 av. 45	?
	Race/Races uncertain			
3	Kurseong (2), Terai (possibly *nipalensis*) ..	128-135 av. 131	41-43 av. 42	8-10 (tails appear tucked in)
1	Darjeeling, ♂ with gloss on head ..	133	44	15
4	Migrants (?) to Samastipur (Darbhanga), Chanda (Maharashtra), and Kendrapara (Orissa) (2) ..	132-139 av. 135	46-49 av. 47·7	11-13 av. 12
1	Haflong, North Cachar ..	135	48	12
1	Bombay (straggler) ..	143	48	9

NOTE.—As there appears to be no difference in size between the sexes, the limited number of measurements are tabulated together.

Hodgson, with the original description, said that it remained in Nepal the whole year. The distribution of this race outside Nepal is uncertain and most records from outside Nepal are very confused. It was listed in the synonymy of *affinis* both by Jerdon (1870, BIRDS OF INDIA) and Blanford (1895, FAUNA), which resulted in everything that did not agree with *affinis* being labelled '*subfurcatus*' including specimens from Nepal, Chanda (C.P., now Maharashtra), Kendrapara (Orissa), Samastipur (Darbhanga, Bihar), and Haflong in Assam.

While the birds from Nepal can be accepted as *nipalensis*, the others are dealt with as a separate group in the table of measurements.

subfurcatus (Blyth, 1849) (Penang)

This was separated from *affinis* as 'larger, deeper coloured, with tail feathers conspicuously more pointed and the outermost measuring $\frac{1}{4}''$ longer than the middle, wing $5\frac{1}{4}''$ [133 mm.], tail $2\frac{1}{8}''$ [54 mm.]. General colour [including head—H.A.] much blacker than in *affinis*, the upper and lower tail coverts being quite black ; the white band on the tail is narrower and less purely white, and the white of the throat is also less pure'. It is also specifically said to be non-migratory. Two fresh specimens from Pahang (Malaya), which is not very far from the type locality, tally entirely with this description. The colour plate in Robinson's BIRDS OF MALAY PENINSULA (1927, **1** : 126) shows a brown head and is probably based on a foxed specimen.

Race/Races uncertain

The birds from north-eastern India have either shorter tails or non-glossy heads, and do not agree with *subfurcatus*. They fall into the following groups :

(*a*) A single specimen recently (1959) collected at Darjeeling differs from *nipalensis* in having a dark glossed head, but its broad white rump (15 mm.) and shorter tail (44 mm.) separate it from *subfurcatus*.

(*b*) Three others from the neighbourhood [Kurseong (2) and Terai (1)] are similar to *nipalensis* in size and colour, but lack the gloss on the back. All are more than 50 years old and may have faded.

(*c*) Four birds with dark tails from non-Himalayan areas [Samastipur (Darbhanga), Kendrapara (Orissa), and Chanda (Maharashtra)] average slightly larger than *nipalensis* and have distinctly longer (46-49 mm.) tails. The one from Chanda is noted in Blanford's FAUNA as *subfurcatus*. These are believed to be migrants to the area—another specimen, which I collected from a nesting colony in Chanda District, is certainly *affinis*.

(*d*) One bird, 17 May 1904, from Haflong (North Cachar) agrees with those in (*c*). Earlier, Stuart Baker (1897, *J. Bombay nat. Hist. Soc.* **10** : 544) referred to the resident birds of North Cachar as *subfurcatus* and spoke of one obtained in the extreme north of the district as being very dark and having a ' rather longer tail than usual '.

(*e*) The bird blown into Bombay is not faded and the brown on the head is quite different from the black of *subfurcatus.* The long tail links it with (*c*) and (*d*) above and, as both *nipalensis* and *subfurcatus* are said to be resident at their type localities, it is possible that this specimen together with those in the last two groups with dark tails but browner heads represent an unnamed migrant form, breeding in eastern Assam.

It would appear from this that *subfurcatus* should be removed from the Indian list, a proposal with which Dr. S. Dillon Ripley agreed when a draft of this note was sent to him.

GENERAL REMARKS

A few other points arising out of this inquiry may be worth noting:

(1) In no Indian race do the sexes show any difference in colour or size, and their measurements are listed together. Of the pair of *subfurcatus* from Pahang (Malaya), the male has a wing 5 mm. longer than the female. A similar difference is seen in 4 specimens from the inner Gulf of Siam. La Touche, 1934, HANDBOOK OF BIRDS OF EASTERN CHINA (**2** : 93), refers to males having ' wings 140-146 and females 136, 137 '. The number of males is not mentioned but apparently only two females were measured.

(2) The black in old skins has foxed, and the older specimens are browner than the more recent ones. The relative differences in the depth of colour on the head, back, and tail, however, remain constant and this character can continue to be used to differentiate the races referred to.

(3) Young (nestlings and flying juveniles) *affinis* and *galilejensis,* which are the only forms available, have white edges to the flight feathers.

(4) In *affinis* the tail grows relatively quicker than the wing. Two chicks, with wings only 85 mm. and 63 mm. (adult average 131) have their tails almost full grown, 39 and 38 mm. respectively (adult average 41).

(5) The swifts in Sikkim and other areas in the north-east area are generally said to be absent from about November to February, but it must be remembered that Stevens (1925, *J. Bombay nat. Hist. Soc.* **30** : 676) said that the birds at Gopaldara and Nurbong 2050 ft. (both not far from Kurseong) remain there the whole year, though during the cold weather ' they are absent for the whole day .... and pairs return to the nests between 4-50 and 5-30 p.m., almost simultaneously '.

ACKNOWLEDGEMENTS

I am indebted to the University of Tel Aviv, the Berlin, Colombo, and British Museums, and the Zoological Survey of India for loan of specimens, to the Zoological Survey of Pakistan for arranging to collect series from Karachi, Mitauri, and Hyderabad (Sind), and to Lord Medway for two specimens of *subfurcatus*.

SUMMARY

It has not been possible to identify racially a swift *Apus affinis* obtained storm-tossed in Bombay. After an examination of the material available, it is suggested that: (a) this specimen may represent an undescribed migratory race breeding in north-eastern India; (b) *A. a. subfurcatus* should be removed from the Indian avifauna.

In Memoriam

ROBERT BERESFORD SEYMOUR SEWELL

Lieutenant-Colonel R. B. Seymour Sewell, C.I.E., M.A., SC.D. (Cantab.), M.R.C.S., L.R.C.P. (Eng.), I.M.S. (retd.), was born on 5th March 1880. He was educated in Weymouth College and Christ's College, Cambridge, and received his medical training in St. Bartholomew's Hospital, London. He was commissioned as a member of the Indian Medical Service in February 1908 and arrived in India in September 1908. He served as Medical Officer with the 34th Sikh Pioneers for two years when, on being selected for civilian assignment, he was appointed as officiating Surgeon Naturalist, Marine Survey of India, from 24th September 1910. In this post he was confirmed from 4th January 1911, and continued to hold it except for a short period when he officiated as the Professor of Biology, Medical College, Calcutta. In October 1914 he was recalled for military service. He served as Medical Officer with the 23rd Sikh Pioneers from 1914 to 1918 and was mentioned in Despatches for services rendered. After a short spell of furlough on medical grounds in 1918-19, he reverted to his substantive appointment as Surgeon Naturalist in April 1919 and, except for officiating as Superintendent, Zoological Survey of India, in 1919-20, continued to hold this post till he was appointed Director, Zoological Survey of India, on probation for one year from 27th July 1925. He was confirmed as the Director after the period of probation and continued to hold this post till he went on long leave preparatory to retirement in April 1933. In 1930 he served as President of the Committee constituted to review and report on the progress of the Indian Institute of Science, Bangalore. His retirement from the Indian Medical Service in 1935 coincided with his retirement from the civilian appointment. *En passant* it is of interest to note that out of some 25 years of service Col. Sewell worked as a medical officer (*sensu stricto*) for not more than six years and the remainder of his service was devoted to hydrographic, marine zoological, and anthropological studies.

During his leave preparatory to retirement he was selected to lead the John Murray Expedition to the Arabian Sea on board the Egyptian vessel *Mabahiss* for carrying out detailed hydrographic and biological investigations in addition to studying the deep-sea fauna of the area; its reports, under the title THE SCIENTIFIC REPORTS OF THE JOHN MURRAY EXPEDITION 1933-34, were issued under the editorship of Col. Sewell.

After his return from this expedition Col. Sewell settled down in Cambridge, and had a room in the Zoological Laboratory of the

University where he carried on active research till about a year before his death on 10th February 1964 at the age of eighty-three.

Under the title FAUNA OF BRITISH INDIA a series of zoological systematic monographs was prepared and published under the authority of the Secretary of State for India from 1880. In 1933, after Lt.-Col. John Stephenson died, Col. Sewell was appointed as the editor of this series. The Second World War brought to a stop all activities in this connection, but Col. Sewell continued actively with the preparatory work in the hope of resuming publication after the war. After Independence, however, the name of the series was changed to FAUNA OF INDIA and its editorship, except for the volumes already sanctioned, was transferred to the Director, Zoological Survey of India.

In 1945 Col. Sewell was invited by the Government of India, Ministry of Agriculture, to come to India and make recommendations for the reorganization and expansion of the Zoological Survey of India. He came towards the end of 1945, and submitted a detailed memorandum dealing with the future and all aspects of the work of the Survey. At the request of the same Ministry he also prepared a detailed memorandum on the proposed Fishery Research Institute in the country.

His scientific work covered a very wide field, from Physical Anthropology to Zoological taxonomic work on various groups, Marine Biology, and Oceanography. His outstanding contributions in the various fields are briefly reviewed in the following paragraphs.

In Physical Anthropology, he in collaboration with Dr. B. S. Guha published valuable memoirs on prehistoric human remains from (i) Nal excavated by H. Hargreaves (*Mem. Arch. Surv. of India* No. **35**, 1929); (ii) Mekran remains recovered by Sir Aurel Stein (idem No. **43**, 1931); and (iii) Mohenjo-daro remains excavated during 1923-27 (MOHENJO-DARU AND THE INDUS CIVILIZATION **2**, 1931). As a result of these studies the authors concluded that during Chalcolithic times in the Indus Valley and in Baluchistan the chief racial types consisted of ' the Mediterranean strain, a large-brained long-headed type of possible Proto-Nordic affinities ' similar to those existing at Kish and Al'Ubaid in pre-Sargonic Sumeria. The origin of man and the population of India in the past and future formed the subject of Col. Sewell's address as President of the Anthropological Section of the 16th Session of the Indian Science Congress at Madras in 1929. In this address he put forward the hypothesis that the causative factor of brachycephaly in man was probably his ' living in high altitudes in the formative period of man's life-history '. A further contribution along the same lines was his address as the General President of the 18th Session of the Indian Science Congress at Nagpur in 1931, in which he discussed certain modifications of bodily structures in so far as these can be regarded as evolutionary problems.

Here may also be mentioned Col. Sewell's detailed report on the prehistoric animal remains excavated at Mohenjo-daro during 1923-27 (MOHENJO-DARU AND THE INDUS CIVILIZATION **2**, Ch. 31, 1931).

Since 1884, investigations on the deep-sea fauna of the Indian Ocean became possible as a result of the sounding and dredging gear which had been used by the *Challenger* expedition being presented for work by R.I.M.S.S. *Investigator*, and such investigations were carried out more or less regularly by the successive Surgeon Naturalists attached to this vessel. As dredging and trawling constituted only a subsidiary function of the Survey vessel, and as such occupied only an insignificant part of the Surgeon Naturalist's time, a major change in the programme of work was decided upon. Consequently a systematic survey of the hydrographic conditions and of the planktonic organisms, especially surface-living Copepods, was started by Captain Sewell (as he then was) from the Survey Season of 1910-11, and this was continued with interruptions from time to time till his relinquishment of that office in 1925. During the first season of his holding this office a mid-water trawl was designed and constructed in the R.I.M. Dockyard at Bombay, which enabled detailed work to be undertaken on the mid-water fauna of the area—these lines of work had hitherto been neglected.

The results of the geographical and oceanographical researches carried out by Col. Sewell were published in a series of papers during 1925-29 (*Mem. As. Soc. Bengal* **9**). This work constituted a detailed study of the conditions under which the marine fauna exist in the Indian Ocean. ' It deals mainly with the geography, the nature of the sea-bed and its deposits, the temperature and salinity of the coastal and surface waters, of the Andaman sea in relation to the adjacent waters like the Bay of Bengal and the Laccadive sea, and the marine meteorology of the Indian seas as a whole. It shows conclusively that the physical conditions of the sea are in an almost continuous state of flux due to influences both within and without its geographical limits, and must be effecting profound changes in the character of the fauna, and that the study of the physical conditions is an integral part of the bionomics of any given arm of the ocean or the sea whatever its size or geographical position.' An offshoot of the same type of work was his joint paper with Dr. N. Annandale on ' The Hydrography and Invertebrate Fauna of the Rambha Bay of Chilka Lake on the Orissa Coast ' (*Mem. Ind. Mus.* **5**, 1922). In an abnormal year such as the one during which the investigations were carried out by the authors, it was found that in this lake of undoubted marine origin a few freshwater forms had established themselves, while the estuarine species were similar to those of the Gangetic delta and the lagoons of the Indian coasts. The occurrence of the truly marine species was only seasonal. ' The most striking features of the fauna of the lake are the abundance of individuals and paucity of species, and the extraordinary adaptability of the permanent residents to the physical changes in their environment.'

Research on the surface-living Copepods was begun with the Survey Season of 1910-11, and the first two papers on the surface-living Copepods of the Bay of Bengal (pts. i, ii) and of the Gulf of Mannar were published in 1912 (*Rec. Ind. Mus.* 7) and in 1914 (*Spolia Zeylanica* **9**). A comprehensive account of the Copepoda of Chilka Lake was published in 1924 (*Mem. Ind. Mus.* **5**), while the detailed monographic work on the Copepods of the Indian Seas was published during 1929-32 (*Mem. Ind. Mus.* **10**). As a result of these detailed studies he concluded ' that much of the apparent difference between surface and littoral Copepod fauna of the Indian and Atlantic oceans was due to the lack of knowledge, and such differences as exist were to be attributed to the presence in the latter of indigenous forms evolved in that area and to the total absence of connecting passages between the tropical or temperate regions of the Atlantic, the Pacific and the Indian oceans.' A further continuation of the same work was the systematic account of the Copepods collected by the John Murray Expedition (THE SCIENTIFIC REPORTS OF THE JOHN MURRAY EXPEDITION 1933-34 **8**, 1947), and on the embionts and parasites of the Copepods of the same area in 1951((idem **9**).

In 1924 he published an interesting paper on the growth of some marine molluscs, such as *Littorina* (*Rec. Ind. Mus.* **26**), and in 1926 was published a detailed account of the Salps of the Bay of Bengal and the Arabian Sea (idem **28**). The same year appeared an interesting account of the variations in the external characters of the several so-called species of the barnacle genus *Lithotrya*, in which he showed that all these species were only stages in growth of, or varieties and life phases of, a single species *Lithotrya nicobarica* (idem **28**).

In connection with the possible introduction and spread of Schistosomiasis in India from war theatres in the Middle-and Far-East, he carried out an extensive programme of research on the Cerceriae found in Indian freshwater molluscs. His comprehensive monograph on the subject was published in 1922 (*Ind. Journ. Med. Res.* **10**, Supplement), while as a result of his detailed studies of the excretory system in the cercariae he ' advanced the view that furcocercous cercariae were of polyphyletic origin, and the evolution of the Monostome by the suppression of the acetabulum has occurred on more than one occasion and in different lines of evolution ' (*Rec. Ind. Mus.* **32**, 1930).

Before being forced by ill health to stop active work in 1963, Col. Sewell was engaged in preparing a volume on Indian Copepoda for the FAUNA OF INDIA series.

Col. Sewell was connected with various Scientific Societies, and served as the Vice-President and President of the Asiatic Society, Calcutta, the Ray Society, London, and the Linnean Society of London. He was a

Fellow of the Asiatic Society, Calcutta, National Institute of Sciences of India, Linnean Society of London, Zoological Society, London, and was elected as a Fellow of the Royal Society, London, in 1934. He was also a Corresponding Member of the Academy of Natural Sciences, Philadelphia, U.S.A.

His services were recognized by the Government of India by the award of the title of C.I.E. in 1933, and he was awarded the Barclay Memorial Medal by the Asiatic Society, Calcutta, in 1932.

Col. Sewell was a Life Member of the Bombay Natural History Society, having joined as a member on 8th October 1910.

Col. Sewell devoted over half a century of his life to advancing our knowledge of Indian Zoology, Oceanography, and Physical Anthropology, and he will be greatly missed by his large circle of friends and admirers.

BAINI PRASHAD

Reviews

1. CARNIVAL UNDER THE SEA. By René L. A. Catala. Translated from the French. Edited and published by R. Sicard. pp. 121 (27·5 × 21 cm.). 27 plates with coloured photographs and 48 black-and-white photographs and diagrams. Paris 1964.

The book is mainly an account of the rare deep-sea animals that have been assembled by the author and his wife Madame Catala-Stucki in the Marine Biology Station and the Aquarium of Noumea (New-Caledonia, South Pacific), and partly a preliminary account of the results of the author's fruitful investigations into the biological phenomenon of fluorescence of deep-sea corals and certain other coelenterates, marine worms, and echinoderms. In the introduction the author cautions the readers that ' the book does not pretend to be a scientific treatise . . . , [but] is intended for the reader who is curious about the beauties of the marine fauna . . . '. A documentary film on the same subject, bearing the same title as this book, has also been prepared by the author.

The text begins with a brief but clear description of the Noumea Aquarium and the special arrangements made in it for keeping the animals under the artificial conditions of a laboratory. The next few chapters of the book deal exclusively with live corals. Short but precise accounts of the different types of coral reefs, the different ways of their formation, their nematocysts (minute, projectile, stinging cells with a complex structure that are situated on the tentacles of these animals), their symbiotic association with *Zooxanthellae* (microscopic algae which provide the corals with an important amount of oxygen), the different methods of reproduction of the corals, and a somewhat detailed account of the fluorescence of the deep-sea forms are included in the book.

The fluorescent property of corals was discovered accidentally by the author in the late fifties, and since then the author and his wife have been in hot pursuit of its secrets. The Aquarium, according to the author, is the only one in the world to exhibit live specimens of corals to the public and to conduct research for finding out the biological properties of their fluorescence. After reading the interesting account of the fluorescent properties of corals, the question that remained uppermost in the mind of the reviewer was ' What could be the adaptive value of fluorescence for these animals ? ' Attempts to find out the answer from this book were of no avail. It is to be hoped that this most important facet of the study will be given its due importance in the detailed account of the fluorescence which the author intends to publish at a later date.

The outstanding feature of the book is undoubtedly the numerous magnificent colour photographs of corals and other marine animals, the live specimens of which have never before been photographed or exhibited to the public. The many photographs showing the difference between the ' normal ' daylight colours of live parts of corals and the colours of the same specimens when the fluorescent substance in their ecto- or endodermal cells is induced by ultra-violet rays, which causes them to fluoresce, as also those showing the remarkable changes in the colour of the fish *Coris angulata* Lacépède as it metamorphoses (Plate XXVII, Figs. 2-5), and again those depicting different types of biological association between animals including instances of ' reciprocal cannibalism ' between two species of solitary corals, and the symbiotic association between the fish *Amphiprion* and species of sea-anemone are all, indeed, exciting. The explanatory captions of these photographs and diagrams, if given along with the diagrams, instead of being listed at the end of the book as has been done here, would have been much more convenient to the readers.

The vivid descriptions of behavioural patterns of many invertebrates, such as coelenterates (*Fungia*'s walking habit), starfish *Luidia*'s various postures (p. 57), the octopus's (the plural form of octopus is octopuses and not octopi) habit of removing the remains of its meal as far away from its lair as possible, the ' amazing reflex ' of the *Ranina* crabs when two specimens meet each other, etc., should be of great interest to students of ethology.

The reviewer takes strong exception to the use by the author of the word ' intelligence ' to explain the above-mentioned behaviour of the octopus. It is well known that many seemingly intelligent reactions of ' lower ' (phylogenetically) animals are performed by them instinctively and the instinctive behavioural patterns being adaptive in nature, just like adaptive structural and physiological modifications, are also inherited by the offspring and become a part of the behavioural repertoire of the animals. Expressions such as ' How intelligent Octopi are ! ' (p. 74) and ' intelligent behaviour of Fish ' (chapter XV), which are clear attempts to attribute complex adaptive instinctive behavioural patterns to the non-existent (?) ' intelligence ' of animals, made even in a book that ' does not pretend to be a scientific treatise ', are misleading and should be avoided. The expression ' amazing reflex ' (p. 86) used by the author in describing the behaviour of the *Ranina* crab is, once again, misleading.

The text, written in unostentatious style, is simple, free from forbidding zoological terminology, nevertheless quite informative. The liberal sprinkling of the author's pleasing good humour has made the reading of the book an extremely pleasant experience. His love and enthusiasm for the subjects of his studies are clearly manifest throughout the text.

The general get-up of the book, i.e. the smooth high quality paper, the clear bold letters, and the wonderful photographs and diagrams are excellent. But the standard of the English leaves much to be desired. Further, the havoc played by the printer's devil is rather conspicuous. For instance, pp. 73-74 of the book, taken up by the reviewer as a random sample, contain not less than fourteen printing errors, which number is of course just too big for making it a good book. Even the very few technical terms used in the book [*mesogloea* as *mesoglee* (p. 20) and *Phylum* as *phyllum* (p. 80)] are usually misspelt.

Despite these shortcomings, the book on the whole is to be regarded as an excellent praiseworthy effort. The reviewer is inclined to agree with Jean Rostand's opinion (expressed by him in the preface of the book) that ' the wealth of information in the text and the unequalled brilliance of its illustrations will delight naturalists, inspire painters, stimulate the imagination of poets and add to everyone's knowledge '. The book is strongly recommended to ' the reader who is curious about the beauties of the marine fauna ' and to school and college libraries in particular.

P. KANNAN

2. THE YEAR OF THE GORILLA. By George B. Schaller. pp. 287 (21·5×14·5 cm.). With 24 plates. London 1965. Collins. Price 30*s*.

In THE MOUNTAIN GORILLA (reviewed in the *Journal* **62** : 133) George Schaller described his field study of the Gorilla in the Congo. This book is a personal narrative of his stay in the gorilla habitat, the country he travelled through, the people he met, and the animals, the gorilla and others, he saw and studied during his eighteen-month stay.

The project, initiated by Dr. Emlen of the University of Wisconsin who accompanied Schaller for the first six months, was sponsored by the New York Zoological Society. It had as its objectives a survey of the gorilla habitat for an assessment of the distribution of the species and intensive field study in a selected area to gather information on an animal which was known more by legends than by facts, a study of whose behaviour could give some clues to human behaviour and to the forces ' that reach thro' nature, moulding men '.

The book, after a brief review of the available information on the Gorilla, gives a very readable and interesting account of the journey through the gorilla habitat during the first six months to study the distribution of the species in the Kivu Province of Congo and the adjoining areas of Uganda. For the next twelve months, Schaller and his wife stayed in a small hut in a high mountain valley in the Albert National Park of the Congo, away from the ' incessant noise and other irrelevant stimuli of civilization ' but close to the gorillas which lived in the near-by forests. His patient endeavours to know them, and to let them know that he meant no harm, succeeded and he was able to accustom several gorilla groups to his presence, making individual recognition of each member of each group possible. Not only the gorilla but also other animals and birds in the area, like the pair of ravens that became tame enough to eat out of Mrs. Schaller's hands, are described with a sympathy, genuine and unsentimental.

It is rather saddening to realize that the Gorilla receives little stimulus to change and adapt, living as it does amongst abundant food and no enemies to speak of. It is as if the gorilla has found what man, in spite of the assurances of his religions and political parties, is, fortunately for him, still striving to find, the Garden of Eden. The Gorilla, it appears, is an animal well on the road to extinction, unless man is magnanimous enough to preserve its ecological niche. The chances seem to be slim.

J.C.D.

3. CLIMATOLOGY: An Introduction. By J. Bucknell. pp. xii+163 (22×14·5 cm.). With 195 diagrams. London and New York 1964. Macmillan and Co. Ltd. Price 18*s*. net.

This book intended to serve as an elementary text book in climatology is written by a Geographer for high school and first year university geography students possessing some knowledge of elementary meteorology ; but it should prove useful to scientists in other disciplines, and to the common man interested in a simple but comprehensive summary of the climates of the world.

The theoretical background is presented in simple language in the first two chapters which deal with the causes and characteristics of climate and the energy and movements of the atmosphere. These chapters naturally suffer from slight inaccuracies arising from oversimplification and, although some details of contents and presentation may be criticized, on the whole the presentation is instructive.

The third chapter deals with the classification of climates, a much debated subject. After briefly describing earlier methods, and Köppen's and Thornthwaite's classifications based on types of vegetation, the author describes Miller's method finally adopted in the book.

The next eight chapters describe in very readable language the main climates of the world, viz. the hot climates, tropical climates, monsoon climates, desert climates, warm temperate climates, cool temperate climates, cold and arctic climates, and mountain climates. The book is written for the British student and the treatment suffers from being addressed to a limited audience. The description of the Indian monsoon contains common errors present in even more advanced treatises.

The last chapter deals with climate and vegetation, followed by questions and exercises and a comprehensive bibliography.

The text is accompanied by numerous graphs, maps, and diagrams, which in general are a model of clear presentation. It would have been more helpful if some of the legends had been more complete, since much seems to have been taken for granted.

The author and the publishers are to be complimented on the production of a handy volume in which the elements of climatology are clearly and attractively presented.

(DR. MISS) A. MANI

Miscellaneous Notes

1. CAN YOUNG BATS COMMUNICATE WITH THEIR PARENTS AT A DISTANCE?

At about 9-30 a.m. a few days ago, my orderly smoked out a dozen or so pipistrelles from behind the wooden panel of our electric meter. The bats flew aimlessly about in the bright sunshine and 3 small young bats fell to the ground under the meter. I had them picked up and placed in a hedge about 25 yards away to save them from crows and other predators. When I went out for a walk at about 5.30 p.m. they were still there.

At about 6.45 p.m. the same evening, the bats made a couple of sorties into the verandah but, instead of alighting on the panel, they flew to the hedge where the young lay. I did not see them carry away the young, but when the place was examined a few minutes later the young were gone.

A specimen of the pipistrelle was later identified at the Society as *Pipistrellus mimus* Wroughton, 1899.

NEW DELHI, MAJOR A. DAVID
August 26, 1965.

[The incident reported suggests interesting possibilities of high frequency vocal communication, inaudible to the human ear, between bats. Brosset (*J. Bombay nat. Hist. Soc.* **59** : 722) refers to the absence of any breeding records in this species from Indian limits; the present observation is interesting in this respect also.—EDS.]

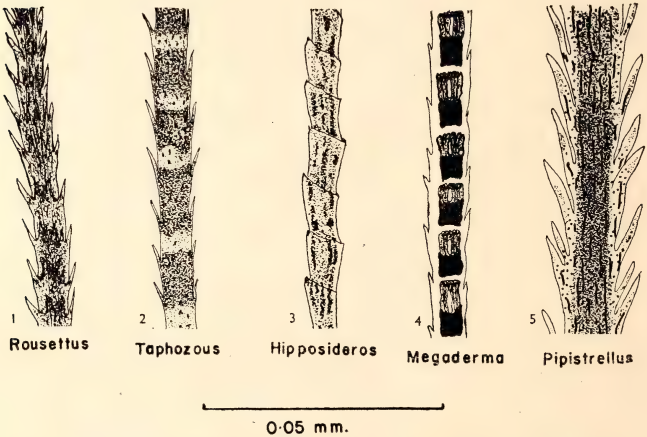
2. NOTES ON THE HAIR OF SOME BATS

(*With a text figure*)

INTRODUCTION

Although hair is one of the characteristic features of mammals there is not much work done so far on the detailed structure of the mammalian hair and there is no record of specific differences in the structure of the hair among related species. Our attention was drawn to this problem while examining the stomach contents of a cannibalistic bat, which invariably included a certain type of hair. During the preliminary examination it was possible to identify these hairs as belonging to the same species and specific differences were noticed in the detailed structure of the hair in different species of bats. This paper presents some observations on the structure of the abdominal hair of five species of bats locally available in and around Aurangabad, one species of Megachiroptera, namely *Rousettus leschenaulti* (Pteropidae), and four species of Microchiroptera, namely *Taphozous melanopogon* (Emballonuridae), and *Hipposideros bicolor* (Hipposideridae), *Megaderma lyra lyra* (Megadermatidae), and *Pipistrellus ceylonicus* (Vespertilionidae).

From each species some hairs were pulled out with forceps from the middle of the abdominal region. They were examined while fresh under the microscope and subsequently permanent unstained microscopic preparations were made for detailed examination.



1. Abdominal hair of *Rousettus leschenaulti* × *c*. 240; 2. Hair of *Taphozous melanopogon* × *c*. 520; 3. Hair of *Hipposideros bicolor*. The distal region is oriented downwards × *c*. 520; 4. Hair of *Megaderma lyra lyra* × *c*. 520; 5. Hair of *Pipistrellus ceylonicus* × *c*. 520.

OBSERVATIONS

The general appearance of the hair in different species varies considerably. In all *Taphozous* the cortical and medullary regions of the hair can be made out. In *Rousettus* and *Hipposideros* the cortical region is exceedingly thin. In all the species the hair is scaly, but there are differences in the size, structure, and disposition of the scales.

Scales

In all the species except *Pipistrellus* the scales are arranged at almost even and regular intervals in the longitudinal axis of the hair, giving the hair a segmented appearance. In all, the scales are distally pointed. In *Rousettus* and *Taphozous* the scales are long, sharp, and pointed. In *Pipistrellus*, which has relatively the longest scales, they are blunt. In *Megaderma* the scales are very short. In these four species the scales are arranged in circles around the axis of the hair. In *Hipposideros* the segmented appearance is due to the expansion of the cortex at the distal rim of each segment so that typical scaly overlaps are not present in this species as in the others.

Pigmentation

The pigmentation of the hair varies. Although basically the pigmentation of the hair in each species is the same throughout its length, different regions of the hair may have different intensities and distribution of the pigment. In *Rousettus* fine pigment granules are evenly distributed throughout the length of the hair. The pigments occur even at the base of the scales leaving only the tips free from pigmentation. The intensity of pigmentation does not vary much along the length of the hair. In *Taphozous* the pigment occurs in alternating segments of light and dark areas thus accentuating the segmented appearance of the hair in this species. The pigments are of two consistencies, namely (i) very fine granules which occur in a closely packed manner, and (ii) thicker granules dispersed unevenly throughout the length of the hair. In this species the general pigmentation is more pronounced towards the distal region of the hair than towards the base, so that it has a more pronounced segmented appearance towards the distal region than towards the proximal region. In the proximal region of the hair the lighter areas are relatively more extensive than the darker areas. In *Hipposideros* there is, in addition to the even distribution of fine pigment granules, additional accumulation of pigment granules in longitudinal bands. If one examines the entire length of the hair of *Hipposideros* one notices that the amount of pigment differs at different lengths. At the very base it is thickly pigmented followed by a short region with very little pigment, and again a short region with thick pigmentation followed by the tip region of scanty pigmentation. In *Megaderma* the pigmentation is most characteristic. In this species the pigment occurs as distinct blocks in a longitudinal series, and these blocks approximately coincide with the segments of the hair marked out by the scales. Each block of pigment consists of two distinct regions, a proximal thick dark part, which appears like a cubical block, on the distal end of which there is a lighter pigmented cylindrical zone with a distinct unpigmented hollow cavity in the centre. The margin of the cylindrical region is serrated.

The entire pigmented block can be compared, in appearance, to a badminton shuttlecock with a solid mass at the base and a conical hollow feathery cylinder attached to it distally. Although the basic pattern of pigmentation in *Megaderma* is the same throughout the length of the hair, the relative sizes of the two parts of each pigmented segment vary at different regions of the hair. In the proximal region the dark part is extensive and the lighter part is short, and progressively, as one examines the length of the hair towards the tip, the lighter part becomes more and more pronounced. Thus, at about the middle of the length of the hair the two parts are equi-extensive, whereas at the very tip of the hair the darker blocks are almost insignificant. In *Pipistrellus* the hair has a central core of thick pigmentation and a peripheral lighter zone. The pigment occurs in three conditions—fine pigment granules mostly occurring closely packed in the central core, and also, in some scales, thicker pigment granules scattered throughout the hair including the bases of the scales, and thick longitudinal filamentous pigment arranged parallel to the longitudinal axis of the hair. In this species the entire length of the hair has almost the same type of pigmentation.

The accompanying camera lucida drawings illustrate the structure of the hair in the five species studied here.

CONCLUSIONS

With the meagre knowledge at our disposal it is not possible at this stage to state if the hair characters can be used as a taxonomic criterion. If a large number of species are studied from this point of view, we may be able to draw conclusions regarding the diagnostic value of hair characters. It is however interesting to note that there are greater similarities between *Rousettus* and *Taphozous* than among the other species. It cannot be said at present if this similarity is of phylogenetic significance.

ACKNOWLEDGEMENTS

We are grateful to Dr. A. Gopalakrishna, Professor of Zoology, Government College of Arts and Science, Aurangabad, for guidance throughout this work.

DEPARTMENT OF ZOOLOGY,
GOVERNMENT COLLEGE OF ARTS AND SCIENCE,
AURANGABAD,
January 6, 1965.

D. R. PATIL
P. N. CHAUDHARI

3. WILD DOGS

Mr. E. R. C. Davidar's interesting note on village dogs joining wild dogs in the hunt in the *Journal* (Vol. **62**, No. 1, pp. 146-8) prompts me to send in this account of an exceptionally close view I had of wild dogs hunting chital in the Masinagudi area of the Mudumalai Sanctuary. This area has long been noted for its chital, which are really big and go about in large herds unlike the chital of the rest of the sanctuary. In recent years, the deer have multiplied here, the opening up of the country around Masinagudi and the Moyar project both being favourable to them, and wild dogs are the main natural check.

Early in October 1963, at about sunset, I noticed a pack of wild dogs hemming in a herd of chital stags on a rise to the east of the eucalyptus plantation in Masinagudi—large stag parties, consisting of animals in hard horn, in velvet, and with polled heads are not uncommon here at this time of the year. The deer were about half a mile away and, above me, between me and them, was a deep hollow with sloping sides. The light was already yellow, but I thought that if I got down to the hollow I might get a picture of the chase, if the deer fled down the sunlit slope on their side. However, by the time I reached the hollow they had already crossed the dip and were galloping towards the plantation, up the slope on my side. Nowadays I find hillsides literally breath-taking but I ran up, hoping to get a clear view from the top, and almost collided with a chital stag in velvet that was bounding down the slope, closely followed by two wild dogs.

One of these was normally coloured and the other, nearer me and only some 10 feet away, was coloured rather like a jackal. I had a clear view of this animal and thought it an exceptionally coloured wild dog; it is hard to be sure of details, or even size, when an animal is running low to ground, as hunting wild dogs (and jackals !) do, but I am quite sure this was no jackal; its ears were rounded and its muzzle deep, and the coloration of its neck and limbs almost chestnut. The deer was distinctly the gainer by my chance intervention, and got away. A few days later, meeting Mr. Davidar in Ootacamund, I told him of what I had seen, and he informed me that there was a report of grizzle-and-black-backed, jackal-like wild dogs in an earlier volume of the *Journal* [Vol. **51** (2): 495-7 (?)—Eds.]. As I wished to scrutinise the wild dogs of this area closer before committing myself to anything, I did not write a note on this, but it did strike me as curious that wild dogs, which have such a wide distribution in Asia and which are, considering all things, so uniformly coloured, should sport a variety in this area alone. I now wonder if the animal I saw could have been a village dog, built remarkably like a wild dog.

Dogs are said to be evolved mainly from jackals and wolves, with the wild dog (which looks so dog-like) contributing nothing to their evolution—this distinction is made on the basis of anatomy, notably of the dentition, and wild dogs have been assigned a genus apart from dogs, wolves, and jackals. I do not think any interbreeding is possible. White markings, even outside the tail-tip, are not unknown in wild dogs.

To continue with my blundering adventure : after this interruption I persisted with my panting climb and, as I topped the rise, so did the main body of the hunt, 8 wild dogs chasing a chital stag that had just shed its antlers—the nearest dog pulled up just in time to avoid colliding with me and stopped momentarily only a yard away. The stag was spent, but going towards the plantation in great bounds ; it was prevented from entering the tree cover by two wild dogs beyond it. As I watched from only 20 yards away, one of the wild dogs on my side ran in for the kill. This run, which I have seen once before, is quite different from the efficient gallop of wild dogs chasing their quarry. It is a mad scurry, with the body so low to ground that the frantic legs seem to kick out sideways at a furious speed, to carry the sprinting hunter to the quarry ; the jaws are open in a snarl, and the quick, rasping gasps of the wild dog are clearly audible. A line of bushes saved the deer from this wild dog, but as it dropped back, another instantly took up the run for the bite. The deer was pulled down about half a furlong away from me, but I had a reasonably clear view of the killing, and noticed once again that it is not merely the jaw-power of the wild dog (which is considerable) but also the forward momentum of the much heavier quarry that is responsible for large lumps of flesh from the neck or flanks, or an entire cheek, coming away in the jaws of the hunter at one bite.

Although photography was now out of the question, I approached the kill furtively, climbing a pile of boulders to get above it. The dogs were busy tearing at the neck and forequarters, which had already been stripped to the bone ; the tail had been bitten off at the base and thrown to one side, and the paunch and much of the intestines removed and flung a few yards away (I noticed both these things in the only other kill I have seen, a sambar hind)—all this within 8 minutes !

The dogs were busy tugging furiously at the flesh and leaping back to detach it, hide and all ; 5 of them were feeding, and 3 stood around panting. In spite of their preoccupation, one of the wild dogs saw me on the boulders, and drew away with a gruff, brief bark, exactly like the interrogatory bark of a large domestic dog not sure of an intruder on its territory. The other dogs looked up, and some of them also indulged in the interrogatory bark ; then they slunk away. I retreated at once, realizing, belatedly, that it was a very wrong thing I had done, intruding on feeding wild dogs in a sanctuary. By now the light was failing rapidly but, when I had gone about a hundred yards away, the wild dogs reassembled with almost hyena-like calls and returned to their kill. I have never before heard either this somewhat fiendish reassembly call or the interrogatory bark, nor have I heard of them.

Incidentally, perhaps the most notable thing about wild dogs in this area is that, though there are any number of cattle grazing in the jungles, they kill only wild animals. Has this peculiar bias of wild dogs, unshared by most other predators, received the study and consideration it merits ?

PERUNKULAM HOUSE,
EDWARD ELLIOT ROAD, M. KRISHNAN
MYLAPORE, MADRAS,
September 20, 1965.

[A photograph of a wild dog mother with her jackal-hybrid pups born in captivity is published on page 198 of Vol. **35** of the *Journal.* This is referred to in Lt.-Col. R. W. Burton's well-documented and informative paper on the Indian Wild Dog on page 691 of Vol. **41** of the *Journal* in which he deals with other points raised by Mr. Krishnan. In particular, Lt.-Col. Burton speaks of the 'hyena-like' chattering of the wild dog when startled or alarmed or at the time of disputing a tiger or panther kill. According to him attacks on domestic stock are unusual; he refers to reports of some, in addition to which we have before us one that comes from Chikmagalur District, Mysore State (*Journal* Vol. **50** : 162-3) .—EDS.]

4. OCCURRENCE OF THE NORTHERN PALM SQUIRREL, *FUNAMBULUS PENNANTI* WROUGHTON, IN THE ANDAMANS

While working on the collections of mammals from the Andaman Islands made by the Zoological Survey of India in recent years, I have come across a specimen of the Northern Palm Squirrel, *Funambulus pennanti* Wroughton, which, according to authoritative literature (Miller 1902 ; Ellerman & Morrison-Scott 1951 ; Ellerman 1961) is not expected to occur there.

The specimen in question is an adult female taken by the Z.S.I. party at Brooksabad, Port Blair, on 24 March 1952. Its external measurements (in mm.) are : head and body 142, tail 147, hindfoot 37, ear 18. It is a study skin without skull and bears the Z.S.I. Regd. No. 12132. In external characters, it does not differ from the population of the mainland of India.

This appears to be the first specimen of the species taken in the Andaman Islands.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
April 29, 1965.

Y. CHATURVEDI

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[Humayun Abdulali (1965, *J. Bombay nat. Hist. Soc.* **61**, at p. 495) in a recent visit to the Andamans saw Palm Squirrels (*Funambulus*) near Port Blair, but did not note the species. He conjectures that they are a recent introduction.—EDS.]

5. A NOTE ON THE BREEDING HABITS OF THE WHITEBELLIED RAT, *RATTUS NIVIVENTER MENTOSUS* THOMAS

(*With a photograph*)

Very little is known regarding the ecology and breeding habits of the Whitebellied Rat, *Rattus niviventer mentosus* Thomas. The only information available regarding its ecology is from the observations of Shortridge (in Wroughton 1916, *J. Bombay nat. Hist. Soc.* **24**: 307), and Roonwal (1949, *Trans. Nat. Inst. Sci. India* **3** : 67-122).

On 10 December 1964, in the course of our study of the field ecology of rats and squirrels in the Khasi Hills, we came across a nest on a tree about 12 ft. high from the ground, on the edge of a scrub jungle at Barapani (alt. *c.* 3500 ft.) about 12 miles north of Shillong.

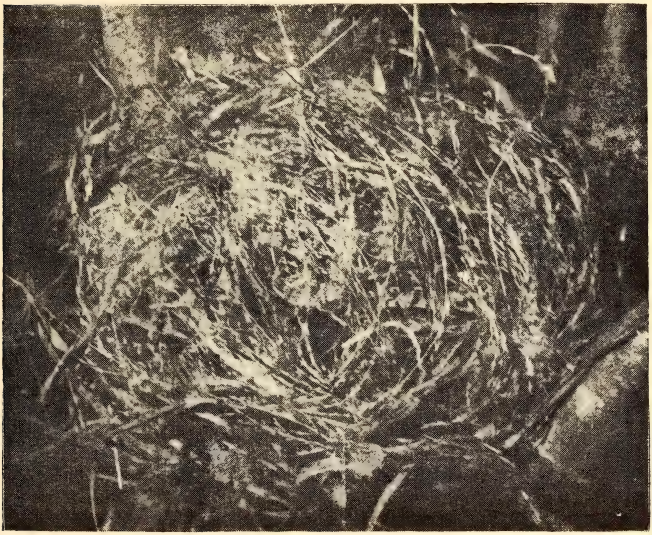
The nest (Photograph) was situated at a fork on the tree. The materials used in the nest were stems, leaves, and spikes of grass *Imperata* sp., lined with bird feathers. It was more or less spherical in shape with a single central opening about 1 cm. in diameter. The outer circumference of the nest was about 45-50 cm. and the inner about 20-25 cm.

The nest contained three young rats, more or less equal in size. Their eyes were unopened, fur smooth and well differentiated, and the belly white with the tail bicoloured as in the adult *R. niviventer mentosus.*

The young when disturbed burrowed deeper into the nest.

Their measurements (in mm.) were as follows:

Head and body	42,	35,	32
Tail	48,	45,	42
Ear	6,	6,	6
Hindfoot	13,	13,	12



Nest of the Whitebellied Rat, *Rattus niviventer mentosus* Thomas in the bifurcation of a tree, *c*. 12 ft. from the ground

Roonwal (1949) noted that this rat is semi-arboreal, and prefers evergreen, and riverine jungle.

The present case as well as the data of an earlier collection by this Department of gravid females at upper Shillong in November suggest a breeding season for this rat in early winter in this area. However, Roonwal (ibid.) collected females with prominent mammæ in July-August but without fœtus.

EASTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
SHILLONG, ASSAM,
May 14, 1965.

A. S. RAJAGOPAL
A. K. MANDAL
S. BISWAS

6. NEST BUILDING BY THE COMMON HOUSE RAT, *RATTUS RATTUS RUFESCENS* (GRAY)

A number of rodents belonging to the subfamily Murinae construct burrows in the soil, for example *Rattus rattus rufescens* the House Rat, *Bandicota bengalensis* the Mole Rat, *Meriones* the Desert Gerbille, and *Tatera* the Indian Gerbille. A few are known to construct regular nests, e. g. *Golunda ellioti* the Indian Bush Rat and *Vandeleuria oleracea* the Longtailed Tree Mouse. Among the species of *Rattus*, Roonwal (personal communication) has observed the building of nest-burrows by *Rattus rattus bullocki*, a rat of semi-arboreal habits found in evergreen scrub and near cultivated fields in eastern India.

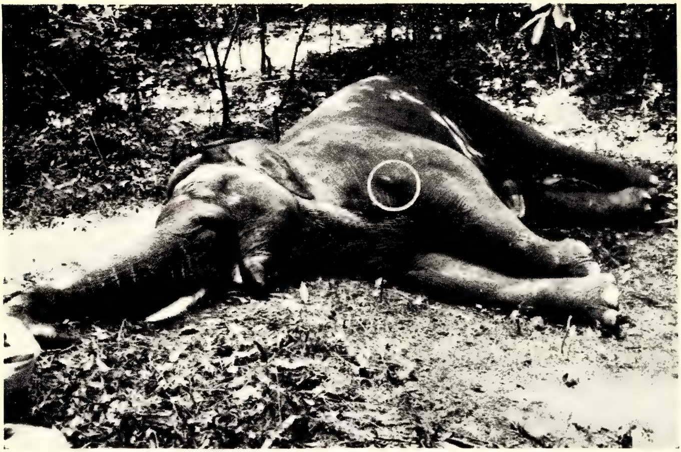
Recently, while on a collection trip, we came across an interesting case of true nest-building, so far not recorded, by the House Rat *Rattus rattus rufescens*. The locality was a suburb of Coimbatore in south India consisting mostly of sugarcane and corn fields. The nests were built in fences of thick growing cacti, eight to ten feet high, surrounding the fields. They were situated at a height of five to six feet from the ground and the intervals between two consecutive nests ranged from six to twenty feet. The nests were rather crude and were built of freshly cut leaves and twigs arranged in an interlacing fashion among the branches of the cacti. The nests were shaped like shallow bowls and resembled the ordinary bird nest. When a nest was disturbed, the animals behaved as if well adapted to an arboreal life, moving with great agility among the cacti along the length of the fence. Many of the nests contained young ones of these animals.

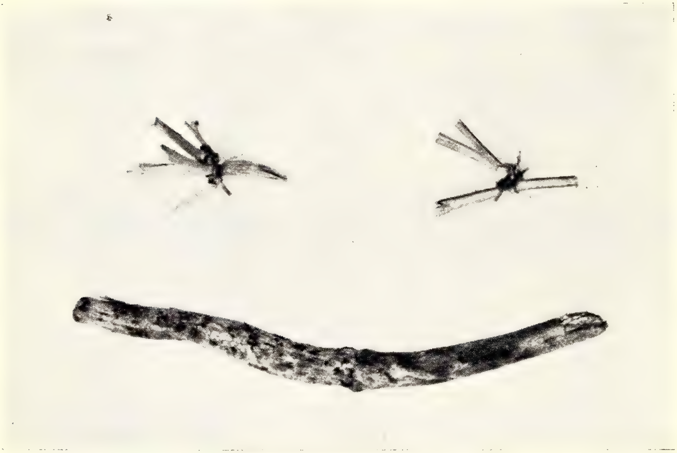
We thank the authorities of the British Museum of Natural History for identifying the specimen sent to them.

DEPARTMENT OF ZOOLOGY,
GOVERNMENT SCIENCE COLLEGE,
JABALPUR, M. P.,
July 19, 1965.

D. R. SHARMA
S. SIVARAM

[Blanford's FAUNA (MAMMALIA) at p. 408 says *re.* this species: 'This rat is found both on the ground and in trees, where it builds nests among the branches. In the Laccadive Islands and other places it inhabits the crown of coconut palms and is said never to descend to the ground . . .' —EDS.]





Above: The dead elephant, with a festering wound at the junction of the front leg and neck (encircled). *Below:* Debris extracted from the elephant's left tusk socket

(*Photos: K. Rajagopal*)

7. STRANGE FIND IN ELEPHANT'S TUSK SOCKET

(*With a plate*)

On 8.8.65 in the Bolampatti Reserve Forest of Coimbatore District, I shot a declared rogue elephant which had trampled seven people to death and had established a reign of terror in the locality.

It had only the right tusk, the left tusk being completely missing. In the process of removing the right tusk, we also opened the socket of the left tusk (photograph). Stuck in the socket we found three arrowhead-shaped bamboo pieces of about 3 inches each. From about 9 inches from the open end of the socket, we extracted a slightly curved piece of wood, about a foot long and 2 inches in girth (photograph). Further inside reaching almost to the root of the socket were pieces of wood decayed into a soft pulp and dark in colour. There was a large quantity of pus in the socket.

There was no trace of the missing tusk, except for a thin layer of ivory attached to the skull bones.

Obviously the animal was suffering from acute pain and irritation. A probable explanation for the presence of the wood debris in the socket is that to relieve pain the animal must have rubbed its head against tree and bamboo stumps or trunks. Probably the pain and irritation eventually turned him into a rogue.

I also give the story told by the local forest staff and hill tribes. According to them about two years ago they heard a terrific noise and found two tuskers engaged in combat. The fight raged for three days and nights followed by silence on the fourth day. When the hill tribes explored the trampled forest and teak plantation they came upon a dead tusker, obviously killed by the other elephant. They claim that this rogue elephant was the victor. Interesting as the tale is, apart from the missing tusk there was no wound or scar to confirm the story.

We found a number of old gunshot wounds in various stages of healing and one or two in a putrefied condition. In the plate the light-coloured spot at the junction of the front leg and neck marks a festering wound.

Among other identification marks was a deformed left rear leg. All we could find was that this leg was longer than the other. The bones, however, showed no defect when the legs were removed for mounting.

I would like to hear about other such cases if any.

348, Avanashi Road,
Post Box No. 31,
Coimbatore 1,
September 21, 1965.

K. RAJAGOPAL

8. STRANDINGS OF FINNER WHALE [*BALAENOPTERA PHYSALUS* (LINN.)] NEAR VIRAR (THANA DISTRICT) AND AT BOMBAY, MAHARASHTRA STATE

On a press report of a stranded whale we visited the village Arnala, *c*. 8 km. west of Virar (*c*. 40 km. north of Bombay), on 6 August 1965, and found the whale stranded on the shore about 3 km. north of the village at some distance from the mouth of the Surya River. Putrefaction had started and the paper-thin skin was peeling. The colour of the unpeeled areas was bluish black dorsally, and whitish ventrally from the chin to near the vent. We took the following measurements:

Total length (tip of snout to notch of flukes) ..	14·10 m.
Length of right flipper	1·50 m.
Snout (tip of snout to hind end of groove between the blow-holes)	2·40 m.

There were 68 ventral grooves or pleats, the middle ones extending back to near the anal region. The area of the blow-holes was elevated into a ridge.

The ratio of the flipper length to the body length, *c*. $\frac{1}{9}$, and the number of the ventral grooves and their extension to the umbilical region identify the animal as *Balaenoptera physalus* (Linn.). From the measurements, it appears to be a subadult.

The local people told us that the whale was first seen spouting in the creek (about 500 m. wide) between the mainland and Arnala Fort Island at high tide on 31 July and was followed in boats by the local fishermen till it stranded. After stranding, the animal showed signs of breathing for some time and the flippers and flukes moved for a longer period.

Again, on the 8th October 1965 a dead and decomposing Finner Whale was stranded among the rocks at Nepean Seaface, Bombay, and drifted ashore the same night. The body which was lying flat on its back had partly sunk into the sand. The skin had peeled off at many places and the hind part of the abdomen was badly crushed. The sides of the body, where there was skin were bluish black; ventrally whitish except on the outer side of the left lower jaw, where it was somewhat dark grey. Skin on the flippers had peeled off.

Measurements:

Total length	15·10 m.
Flippers (left and right)	1·65 m.
Number of pleats	72

The pleats at midbody extended far behind the flippers but, as the lower abdomen was damaged, their termination could not be determined.

Anderson's (1879) *Balaenoptera blythii* from the Indian coast is listed as a synonym of *B. physalus* by Ellerman & Morrison-Scott (1951).

However, Blanford (1891) states: '. . . there is no evidence as to the locality whence came the few vertebrae to which Anderson (*An. Zool. Res.* : 564) gave the name of *B. blythii*, it is uncertain whether these bones are of Indian or even of Asiatic origin.'

Besides this, there are reports of two more strandings, one by S. H. Prater (1914), and the other by V. K. Chari (1950). Both were identified as *B. indica* (= *B. musculus*) but seem nearer to *B. physalus* (see C. A. Gibson-Hill 1950 and J. C. Daniel 1963). In the absence of information as to the number and the extent of the pleats, their identity cannot be satisfactorily established.

Bombay Natural History Society,
Hornbill House,
Bombay 1-br,
December 27, 1965.

B. ROBERT GRUBH
M. J. PEREIRA

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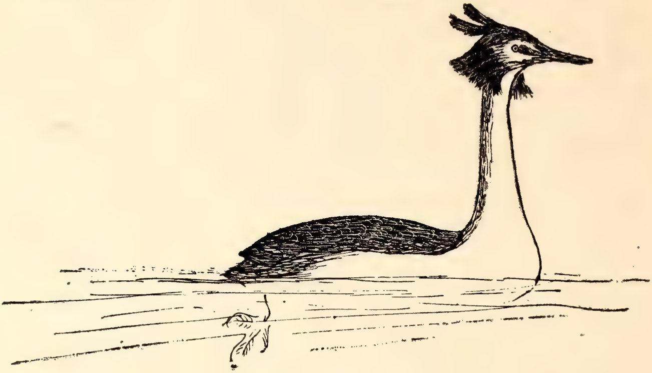
Prater, S. H. (1914) : Note on a stranded Great Indian Fin Whale (*Balaenoptera indica*) at Ratnagiri. ibid. **23** (3) : 576.

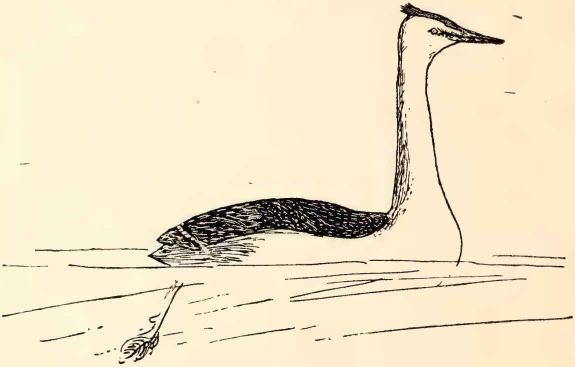
9. THE GREAT CRESTED GREBE [*PODICEPS CRISTATUS* (LINNAEUS)] IN KUTCH

(*With two text-figures*)

Since the days of F. Stoliczka and A. O. Hume in the 19th century some of the birds listed by them from Kutch have not been seen or recorded by any one. The credit for the discovery of one such bird goes to His Highness the Maharao Saheb of Kutch, my brother, who informed me on 23 May that he had seen six birds on the Rudramata Dam (9 miles from Bhuj) which he thought he had never seen in Kutch. Keen sportsman and experienced observer that he is, his apt and exact description of the plumage of the birds, their behaviour, and so on helped me to identify them at once as Great Crested Grebes [*Podiceps cristatus* (Linnaeus)]. When I went to Rudramata Dam that evening I failed to see them. However, on May 27 I went again with my brother and had the luck to see the six birds, and so any doubt I had in my mind about their identity was dispelled. I failed to collect a specimen for the Society, as the grebes kept on swimming and diving out of range of my gun.



Summer



Winter

Dharmakumarsinhji (BIRDS OF SAURASHTRA, p. 4) says that Bulkley records a pair having bred at Kharaghoda in August, but it is not mentioned in which year the pair was observed breeding. Although this is by no means an unusual occurrence in Kutch as this bird is said to visit Sind (West Pakistan) as well, it can very well be put among the rare visitors. Stuart Baker (FAUNA OF BRITISH INDIA **6** : 479) also mentioned a breeding record in Karachi. So I shall not be surprised if the Great Crested Grebe breeds in Kutch too once in a while.

JUBILEE GROUND,
BHUJ, KUTCH,
June 12, 1965.

M. K. HIMMATSINHJI

[The Great Crested Grebe is an irregular but not unusual winter visitor to India, reaching south as far as Kathiawar in the west and Puri (Orissa) in the east. It breeds in large numbers in the lakes of Ladakh and Tibet, rarely in the Vale of Kashmir, and sporadically in the plains, having been recorded from Karachi, Oudh, and the Doab. Bulkley's record from Kharaghoda relates to the year 1891 (*J. Bombay nat. Hist. Soc.* **6**: 501).

In the hope that our readers may be encouraged to keep a look-out for the bird we give an illustration and a short description: An aquatic bird, distinguishable from the duck by its pointed bill, thin neck, lobed feet, and tiny tail. Size of adult (from tip of bill to tip of tail) 19 inches. Dark crown and short or incipient ear-tufts. White stripe over eye. Grey-brown upper parts. Satiny white lower parts. In summer, expansible chestnut and black frill on side of head. Juveniles and nestlings, striped black and white.—EDS.].

10. NOTES ON INDIAN BIRDS 6—THE OCCURRENCE OF THE PYGMY CORMORANT [*HALIETOR* (*PHALACROCORAX*) *PYGMEUS* (PALLAS)] IN BALUCHISTAN. AN ADDITION TO THE AVIFAUNA OF PAKISTAN

While going over the ornithological collections of the Bombay Natural History Society, a report on which is under preparation, we found a specimen of the Pygmy Cormorant [*Halietor* (*Phalacrocorax*) *pygmeus* (Pallas)] bearing register No. 15009 and the following data:

3200 Gujar, Mashkai [?] 165 m. SSW of Kalat
[on] 3.9.17. Collected by Capt. J.E.B.H.[otson].

This bird along with two others from Amara, Persian Gulf, and Enzil, Gilan, N. Persia, though marked *Phalacrocorax pygmeus* on the labels were listed under *Phalacrocorax niger*, an error which one of us (H.A.) had noticed some years ago and marked in the register. He however overlooked the fact that one of them was from Baluchistan and constituted an addition to the avifauna of Pakistan. The thicker bill, the brown head, and the curious filoplumes scattered over the neck and lower parts are very distinctive.

75, ABDUL REHMAN STREET,
BOMBAY 3-BR, HUMAYUN ABDULALI

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE, M. J. PEREIRA
BOMBAY 1-BR,
September 27, 1965.

11. NOTES ON INDIAN BIRDS 7—ON THE SIZE OF THE WHITE EGRETS IN INDIA (*EGRETTA ALBA*, *INTERMEDIA*, AND *GARZETTA*)

When working out my collection from the Andaman Islands (*J. Bombay nat. Hist. Soc.* **61**: 502), I identified a female egret from North Button Island, Middle Andamans, as *Egretta intermedia intermedia* (Wagler). I have now had occasion to examine and compare all available specimens of the 3 species of *Egretta*, i.e. *alba*, *intermedia*, and *garzetta*, and though the number both in breeding and non-breeding plumage is limited the conclusions arrived at after much effort appear to be worth recording.

Seven skins registered as *intermedia*, together with a specimen with a yellow bill transferred from *garzetta* by me, had wings measuring from 296-361 mm. (FAUNA 304-333, once 354) and these could be divided by size into two separate groups :

		Wing	Bill (from feathers)	Tarsus
Larger :	3 ♀♀	337-361	96-100	126-134
E. alba modesta		av. 346	av. 98	av. 131
Smaller :	2♂♂, 2♀♀, 1 o?	296-305	70-77	99-110
E. intermedia		av. 301	av. 73	av. 105·4

The smaller birds (including one with the dorsal plumes extending far beyond the tail) could be separated from *garzetta* by their larger wings (251-290 av. 275 in *garzetta*) and shorter bills (85-90 av. 86 in *garzetta*), but the larger birds included one bearing a pencil note by Dr. Sálim Ali '*Egretta intermedia* det. C. B. Ticehurst' but no further remarks. I took it that this meant agreement with the identification and had been noted as a guide to future workers. After I had been forced to the conclusion that the three larger birds could only be *Egretta alba modesta* (J. E. Gray) in non-breeding plumage, I noticed that Sálim Ali had already (*J. Bombay nat. Hist. Soc.* **52**: 383) decided that Ticehurst had made a mistake regarding this specimen.

Accepting the three larger birds as *E. alba modesta*, the males of this species average appreciably larger than the females[1] :

	Wing	Bill (from feathers)	Tarsus
4♂♂*	347-382 av. 370	110-115 av. 113	147-165 av. 156
4 ♀♀	337-361 av. 348	96-100 av. 98	126-147 av. 135

* This includes an unsexed specimen, which is the largest.

A single unsexed specimen from Sind is much larger—Wing 447, Bill 126, Tarsus 215, and is of the nominate form.

No all-white specimen of *Egretta gularis schistacea* is available.

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[1] After completing this note I see that Tom Iredale (1956) in BIRDS OF NEW GUINEA 1: 109 states that this species 'increases in size with age and an old male is much larger than a young, fully grown, bird'.—H.A.

This examination appears to establish that:

(1) *intermedia* are much smaller than indicated in the FAUNA and that there should be no difficulty in separating them from *E. a. modesta*, by size alone;

(2) the bird collected by me in the Andamans is really *E. a. modesta* and serves to establish the occurrence of this species in that area.

Regarding the first conclusion, I would repeat that I realize the paucity of material on which it is based, but the published measurements have caused so much difficulty and confusion that I think it worth while accepting an apparently obvious alternative. I hope that somebody with access to more material will check upon my findings.

I am grateful to M. J. Pereira of the Bombay Natural History Society for assistance in handling and measuring the specimens.

75, Abdul Rehman Street,
Bombay 3-br, HUMAYUN ABDULALI
October 8, 1965.

12. OCCURRENCE OF THE MARBLED TEAL, *ANAS ANGUSTIROSTRIS* MÉNÉTRIÈS, IN MAHARASHTRA

Specimen No. 15491 in the collection of the Bombay Natural History Society shot by Major C. W. Ridley at Kapurwaddi Tank, Ahmednagar, Maharashtra, on 26th January 1947, was correctly registered as *Anas angustirostris* Ménétriès. Earlier, one was shot at Ravengaon Lake, 54 miles south-east of Poona (*J. Bombay nat. Hist. Soc.* **38**: 196), but both are omitted from Ripley's SYNOPSIS in which the southernmost records are said to be from northern Gujarat.

75, Abdul Rehman Street,
Bombay 3-br, HUMAYUN ABDULALI

Bombay Natural History Society,
Hornbill House, P. B. SHEKAR
Bombay 1-br,
December 3, 1965.

13. SIMULTANEOUS MOULT OF REMIGES IN ANHINGIDAE

In his note ' On an ornithological trip to the Gulf of Kutch ' at p. 656 of Volume **59** of the *Journal*, Mr. Humayun Abdulali described a darter (*Anhinga melanogaster*) collected on 28 July 1962 in moult with its wing quills hardly an inch and a half long and remarked that, though this flightless condition has been noted in several species of duck wintering in India, he had not seen it mentioned for any of the Phalacrocoracidae. It may therefore be of interest to note that, in article ' Moult ' at p. 488 of Thomson, A. L. (ed.) : A NEW DICTIONARY OF BIRDS, Dr. J. M. Harrison after referring to simultaneous moult of remiges in certain species of ducks (Anatidae) adds that it is ' also found in flamingos (Phoenicopteridae), grebes (Podicipitidae), divers (Gaviidae), and darters (Anhingidae).

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY 1-BR,
September 6, 1965.

EDITORS

14. OCCURRENCE OF THE BLACKCRESTED BAZA [*AVICEDA LEUPHOTES* (DUMONT)] IN MADHYA PRADESH

Going through the bird collection of the *Bombay Natural History Society* we found the fragments of a Blackcrested Baza [*Aviceda leuphotes* (Dumont)] along with a label marked: ' GIDUM (C.P.), Buster State 24.4.36 H. V. Blackburn '.

The specimen probably because of its tattered condition was not registered and the label presumably fell apart. We have gone through the whole register and cannot find *any* other bird received from Mr. Blackburn, nor any specimen in the same shelf to which the label could refer. The label is also marked in pencil ' W(ing) 236 ' which measurement in millimetres is within the range of this species.

Ripley recognizes two forms from Indian limits, the nominate form from Pondicherry, and *syama* (Hodgson) from Nepal. We have been unable to see any differences between the single southern specimen available from Coonoor and two from Darjeeling which should represent the two races.

The species, though believed to migrate into Ceylon and Burma, does not appear to have been recorded from the Central Provinces (now Madhya Pradesh).

75, ABDUL REHMAN STREET,
BOMBAY 3-BR,

HUMAYUN ABDULALI

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY 1-BR,
December 21, 1965.

V. C. AMBEDKAR

15. WINTER FOOD OF THE PAINTED PARTRIDGE [*FRANCOLINUS PICTUS* (JARDINE & SELBY)] IN RAJASTHAN

With reference to the observations of Mr. S. C. Sharma about the feeding habits in winter of the Painted Partridge [*Francolinus pictus* (Jardine & Selby)] in Rajasthan on pages 686-688 of the *Journal* for December 1964, Vol. **61** (3), I wish to point out the following:

(*a*) I have shot hundreds of Painted Partridges in Rajasthan, particularly in the Kekeri-Sarwar regions of Ajmer District and round about Mhow in Central India. When I was younger I particularly enjoyed cleaning the birds also, and when doing so, on no occasion, did I find any lady-bird beetle and only very rarely big black ants in their crops. On the other hand these have been found to contain, in a very large number of cases, termites, small red ants, moth larvae, and other small insects; also grains like barley, *bajra*, grass seeds, and a small berry locally called *dansra*.

(*b*) It therefore follows, though I speak subject to correction, that the feeding habits of the Painted Partridge in winter are not uniform but depend on the type of food available. I would go so far as to say that its feeding habits are closer to its cousin the Grey Partridge and, like the Grey Partridge, it comes on the roadside and pecks cattle dung, looking for undigested grain.

NEW DELHI, Major A. DAVID
August 26, 1965.

16. THE WHITECHEEKED DRONGO [*DICRURUS LEUCOPHAEUS SALANGENSIS* REICHENOW]: AN ADDITION TO THE INDIAN AVIFAUNA

While working on a collection of birds from Nagaland, I came across a specimen of the Whitecheeked Drongo [*Dicrurus leucophaeus salangensis* Reichenow], which according to standard works (Baker 1924; Vaurie 1949, 1959) does not occur anywhere within the Indian limits.

The specimen is an adult male collected by the Naga Hill Survey Party of the Zoological Survey of India at Chizami (Khezhabama), about 28 km. ESE. of Kohima, Nagaland, on 20 January 1936. Its measurements (in mm.) are: wing 135, bill 26+. The outer tail feathers are missing. The specimen is in the collection of the Zoological Survey of India bearing Reg. No. 29558.

This appears to be the first specimen of the subspecies known from India.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
May 1, 1965.

P. K. DAS

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[The author's identification has been confirmed by Dr. Biswamoy Biswas, Zoological Survey of India, Calcutta. Vaurie (1949) gives the range thus: 'Southeastern China inland, south from the Yangtze, along which it intergrades with *leucogenis*, and on the coast south from the Fukien-Kwangtung boundary. Migrates to Hainan, and through Indo-china and eastern and southern Siam to the Malay Peninsula as far south as Malacca.' He gives for ♂♂: wing 139-145 (143), ♀♀: 137-145 (141·50) mm. For an 'adult male' the specimen appears to be rather small.—EDS.]

17. PIED WHEATEAR, *OENANTHE PICATA* (BLYTH) AT KANYAKUMARI, SOUTH INDIA

In October and November 1964 I spent three weeks at Kanyakumari staying in a house overlooking the sea about three quarters of a mile west of the actual cape. From here my daily walk took me along the sandy boulder-strewn cliff to the point where it ends about half a mile further west still.

On this stretch of coast, on 21st October, I saw a bird which I was not able to identify. It flew low and fast above the ground along the edge of the cliff immediately above the shore, perching upright on boulders or flat rock surfaces when it alighted.

In the subsequent two weeks I saw the bird repeatedly and was able to observe it closely. Its build and behaviour suggested a wheatear, but I could find no references at all to wheatears in any of the books on south Indian birds which I had with me. I did not even know if wheatears were found in north India.

On return home I consulted Whistler (POPULAR HANDBOOK OF INDIAN BIRDS). From this it appeared that the bird seen at Kanyakumari resembled a female Pied Wheatear, *Oenanthe picata* (Blyth). The tail had been the distinctive feature of the bird and fitted Whistler's description: 'white except for a broad black band across the end, widening on the central pair to nearly half of the feathers.' Whistler says that in the case of the female the black is replaced by brown. In the case of the bird at Kanyakumari it seemed blackish brown.

As Whistler made no reference to any appearances of this bird in south India, I was on the point of writing to ask your Society if such visits south had been recorded before. Before writing I again consulted Henry (BIRDS OF CEYLON) in which I had previously been unable to find any reference to wheatears. This time I discovered, on p. 25, a note in which he tells of seeing a wheatear in a Colombo garden, on 16 November 1943, in a very exhausted state. He presumed that it was a bird recently arrived from India. He later compared his notes and sketches made at the time with specimens in the Natural History Museum, London, and concluded that this bird was a female Pied Wheatear, *Oenanthe leucomela*.

I was very pleased that this record from Ceylon brought my very tentative conclusion regarding the bird at Kanyakumari into the realm of possibility. I wonder if there are any records of it having been seen previously in south India?

DOHNAVUR,
TIRUNELVELI DISTRICT, S. INDIA,
March 2, 1965.

MARGARET E. WILKINSON

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18. NOTES ON INDIAN BIRDS 8—OCCURRENCE OF THE BLACKHEADED MUNIA [*LONCHURA M. MALACCA* (LINN.)] NEAR BOMBAY

In the morning of 4 August 1965, I took P. V. George, Junior Research Assistant, Council of Scientific and Industrial Research, to a small patch of low mangrove-cum-sea-holly (*Acanthus ilicifolius*) between a branch of the Thana Creek and the Agra Road, on the far side of the bridge at Thana, Maharashtra, to see if he could find nests of the Indian

Great Reed Warbler (*Acrocephalus stentoreus*) which I had often seen and heard there.

While George laboured unsuccessfully in the mud and I sat by the roadside, I saw a pair of Blackheaded Munias [*Lonchura m. malacca* (Linn.)] fly across the road and settle in the mangrove—the black patch on the white underparts identified them subspecifically. We were there for about an hour and during this time, though no nest was found, the pair returned to the same patch on several occasions and another party of four was also seen.

This distinctive munia is well known in Ceylon and south-west India, south of Belgaum. There are a few records from further north in peninsular India—Pachmari, Hoshangabad District, Bates; Pakhal Lake, Warangal District, Sálim Ali; Kolair Lake, Godavari District, Col. Sparrow; Bhandara, Madhya Pradesh, Blewitt; Ratnagiri, Vidal—which all refer to birds seen only once. Blewitt refers to the other race *atricapilla* (Vieillot) nesting half-a-mile away.

No earlier records from near Bombay appear to have been published, though Br. A. Navarro, S.J., took eggs at Khandala on 28 October 1938, and I have an undated note of a recollection of a party seen at Lake Beale, Nasik District, in the course of a snipe/duck shoot. On 26 January 1954, I shot one in Thana District (B.N.H.S. Sp. No. 19733); later I discovered that its wing feathers were trimmed, so that it was undoubtedly an escaped or released bird. Layard's record of *atricapilla* from Galle, Ceylon, and Osmaston's of *malacca* from the Andamans have both been similarly accounted for and I cannot help expressing the feeling that these remarks probably apply to the records north of about the 18th latitude, all of which indicate a discontinuous and local distribution.

Incidentally, Vidal (loc. cit.) refers to 2 specimens of *Amadina rubronigra* Hodgs. obtained by Dr. Armstrong in the Ratnagiri District. One of these is available in the Society's collection and the label is marked '*atricapilla-malacca* hybrid'. This has the primaries in one wing missing, presumably indicating a captive specimen.

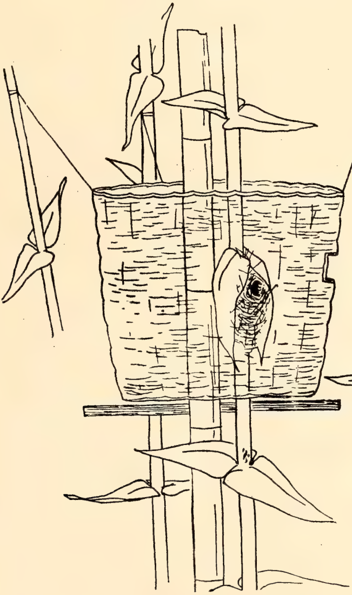
75, Abdul Rehman Street,
Bombay 3-br,
August 10, 1965.

HUMAYUN ABDULALI

19. TWO WAYS TO HELP NESTING BIRDS IN YOUR GARDEN

(*With a sketch*)

There must be many bird-lovers who have seen their garden honoured by the nest of some small bird only to suffer the acute distress of finding the eggs or nestlings butchered by a crow or other predator. And if the nestlings somehow survived, their human friends must often have watched the parents' frantic attempts to satisfy from three to five ravenous appetites and vainly longed to find some way in which they could help.



Nest of Ashy Wren Warbler (*Prinia socialis* Sykes) in protecting basket (Diagrammatic)

Our own experience with a family of Ashy Wren-Warblers, *Prinia socialis* Sykes, who nested in our tiny fenced garden, suggests that help *can* be given, both in safeguarding the nest and in feeding the nestlings.

Our warblers built the usual globular, side-opening type of nest in our zinnia bed. A zinnia's main stem passed right through the nest, over which one pair of leaves was folded down and stitched to form a roof. So unobtrusive was the construction work that we never noticed it till 12 September, by which time it was largely completed. The first egg was laid on 21 September, and on the 27th we observed four eggs in the nest. During incubation, the little hen became fully used to our presence and tolerated even a very close approach.

On 6 October the parents were observed bringing green caterpillars, the eggs having all hatched. Nine days later, we were lucky enough to visit the garden just in time to save the fledglings from a Crow-Pheasant, which had evidently discovered the nest and was so persistent that it returned within a few minutes of having been driven off. We thus felt ourselves forced by necessity to the invention of some sort of protective device. And this is what we did.

We took an inch-thick bamboo and fitted a cross-piece at such a height that, when the bamboo was set firmly in the ground beside the zinnia plant, the cross-piece would be some 3 to 4 inches below the nest. This was duly fixed, as close as possible to the stem running through the nest. During the whole process, of course, we were frequently 'driven off' by the food-bringing parents.

Next we took a basket — the ordinary common type supplied by stores and fruit-sellers — and in its bottom we cut a hole slightly larger than the nest. The basket was then slipped over the zinnia stem and nest, until it rested on the cross-piece. The bottom of the basket was then re-floored with any handy material, and the whole basket was attached by strings to two or three neighbouring stems, in order to keep it from tilting. We had of course already cut a *small* hole in the side of the basket, turning the basket so that this hole came directly opposite the nest opening.

Now we left the basket in position with the top open, so that the birds could readily see that their nest was still there. The hen accepted the 'improvement' with only a moment's hesitation, but the cock was rather suspicious. However, both birds visited the nest either from the top or through the specially cut hole in the side of the basket. On seeing this, we closed the top of the basket with a piece of thick cloth. Henceforth, the hen visited the nest through the little hole as readily as though the basket had always been there; but the cock began to give up his visits altogether. He had always shown himself to be a hysterical and ultra-cautious creature, in marked contrast with his mate. In fact, from now on we never saw him again; so it is perfectly possible that he met with an 'accident' in this wicked world of crows, cats, and small boys.

This protective arrangement, which I have illustrated in the accompanying diagram, did more than preserve the nest from crows and crow pheasants; it also safeguarded the fledglings for those first two critical days after they spilled out of the bulging nest. Instead of squatting exposed on stalk or ground beneath, they could jump and flutter about the inside of the basket growing ever stronger and more capable in perfect safety. By the time they refused to stay inside the basket (18 October) they were a couple of days older, and by then much better able to take care of themselves.

The withdrawal of the cock bird threw a tremendous strain on the gallant little hen. The failure of the monsoon in Poona had also seriously diminished the supply of insect food. My daughter and I therefore felt impelled to try to supplement the mother's efforts by catching cockroaches inside our flat and flies and grasshoppers outside.

Whatever we caught we laid on a freshly-cut canna leaf, which we placed in such a position that the hen would be bound to notice it as she reached the nest with her own catch. At first we placed the leaf close to the basket; after the chicks scattered over the garden, we used to place it on the path close to wherever they were roosting.

To our delight, the little hen immediately took advantage of our proffered help. She quickly learned to visit and inspect the leaf as soon as she had disposed of her own catch. After a while, she even learned to recognize our special call, by which we sought to inform her that we had brought food for her. She would watch us while we placed our insects (numbed by pinching, but not squashed flat) on the leaf, and pounce down upon them the moment we slightly withdrew.

One cannot of course say whether our little bird was an abnormally intelligent and co-operative specimen. But I have thought it worth while to describe the ways in which she allowed us to help her, in order that other bird-lovers may do likewise — or perhaps still better — in appropriate circumstances.

DEV KUNJ,
PRABHAT ROAD,
POONA 4,
October 26, 1965.

THOMAS GAY

20. RECOVERY OF RINGED BIRDS

Ring No. and species	Date and place of ringing	Date and place of recovery	Remarks
AB-11018 *Tringa glareola*	2.4.1965. Beliaghata, North Salt Lake, Calcutta (*c.* 22·35 N., 88·21 E.), India	+, 25.5.1965. Almaznyi near Mirnyi, Yakutian, ASSR, Mirnyi (*c.* 62·32 N., 113·50 E.)	Reported by Bird-Ringing Bureau, USSR
C-1701 *Anas crecca* ♂	3.12.1964. Manjhaul (*c.* 25·23 N., 86·30 E.), Monghyr Dist., Bihar, India	+, 22.9.1965. At Sergo (50 km. NE. of Bodaibo), Irkutsk region (*c.* 58·15 N., 114·50 E.)	do.
C-1765 *Anas crecca* ♀	5.12.1964. do.	+, 28.8.1965. In Obskoe near Kamen'-na-Obi, Altai territory, USSR (*c.* 53·38 N., 81·40 E.)	do.
C-1778 *Anas crecca* ♀	5.12.1964. do.	+, 30.5.1965. At 'Kusalan-Kel'' Lake near Dyullyukyu, Yakutian, ASSR (*c.* 63·43 N., 120·30 E.)	do.
C-1919 *Anas crecca* ♂	3.1.1965. do.	+, 22.8.1965. Near Chistoozernoe ('Ozero Kuschevatoe'), Novosibirsk region, USSR (*c.* 54·42 N., 76·35 E.)	do.
F-3537 *Anas crecca* ♀	15.2.1964. do.	+, 26.9.1965. At 'Gusinoe'-Lake, 2 km. south of Gusinoe Ozero, Buryatiaj, USSR (*c.* 51·05 N., 106·18 E.)	do.
F-3551 *Anas crecca* ♀	16.2.1964. do.	+, in spring 1965, *c.* May. Near Erzin (The Tuvin ASSR) (*c.* 50·15 N., 95·10 E.)	do.

Ring No. and species	Date and place of ringing	Date and place of recovery	Remarks
US Fish & Wildlife Service 647-27146 *Catharacta skua maccormicki* Dark-phase bird	5.3.1961. Gonzales Videla Base, Antarctic Peninsula (*c.* 64·49 S., 62·51 W., a Chilean International Geophysical Year Station in the Antarctic. Ringed by the United States Antarctic Research Program (U. S. A. R. P.) Bird Banding Project, Antarctica	× (died in captivity), 7.8.1964. Udyavara (South Kanara), Udipi (*c.* 13·23 N., 74·45 E.), Mysore State	Captured by Mr. Pappu Marakala of Udyavara and brought to Mr. M. Madhva Raj, M.L.A., Malpe, South Kanara

Note. + = shot or killed by man.
× = found dead, or ill/exhausted, and eventually died.

Bombay Natural History Society,
Hornbill House,
Bombay 1-br,
January 28, 1966.

EDITORS

21. PLANTS EATEN BY *UROMASTIX MICROLEPIS* BLANFORD AND OTHER NOTES ON THIS LIZARD IN EASTERN ARABIA

I was very interested in what Mr. Mandaville has written in your publication (*J. Bombay nat. Hist. Soc.* Vol. **62**, No. 1) for April 1965.

My experience in Kuwait with young spinytailed lizards, which used to be given to us for the children to play with, was that they would eat green *alfalfa*, which we gave them daily in their box.

As Mr. Mandaville observed, the full grown lizards in captivity would eat nothing.

That they eat locusts also is possible. I quote from THE ARAB OF THE DESERT, by H. R. P. Dickson :

'In 1932 . . . I remember once, when coming home with my wife from the Batin by car, meeting a swarm of locusts flying very low across the plain west of Jahra. It was near sunset, and we saw several full sized *dhubs* and *wurral* on the side of the track chasing the flying locusts and jumping in the air to catch them. We were so much interested at the sight that we stopped our car and watched for some five minutes, There were eight large monitors—*wurral.* In their excitement they appeared oblivious of our presence.'

I have also eaten a piece of the lizard's tail roasted and found it good.

SEEF,
KUWAIT, (Mrs.) V. P. DICKSON, C.B.E.
October 23, 1965.

22. LAND MONITOR PREYING ON BATS

On 26 August 1965 at about 9 a.m. I saw one young of the large land monitor (*Varanus* sp.) going up a jak fruit tree. Three small bats were hanging from the first limb of the tree, about 3 metres from the ground. The monitor, went towards the bats very slowly and cautiously, repeatedly stopping and watching them. When it was hardly 30 cm. from the bats, it made a quick rush and caught the nearest one head first and came down the tree with the bat still fluttering in its mouth. The other two flew off.

After coming down the monitor swallowed the bat with three or four jerky movements. The whole operation from catching to swallowing took hardly a minute.

The monitor was 75 cm. tail included.

So far as I know bats have very few natural enemies—the smell of bats is a good defence. I have seen these monitors going up trees quite often, and thought they were after the young and eggs of birds. If a 75 cm. monitor could do this, it is possible that full-grown monitors prey on bigger bats.

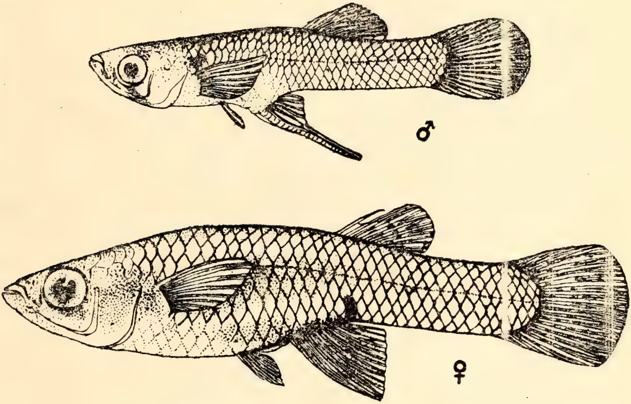
RANGE FOREST OFFICE,
MAZBAT, DARRANG, K. K. GUPTA
ASSAM,
September 2, 1965.

[Most species of bats have distinctive smells but there is no reason to believe that this is protective and prevents their being eaten by the normally carnivorous predators, for instance the Hobby (*Falco subbuteo* Linn.), which is more crepuscular than other hawks, is well known to take bats when they appear at dusk. Large populations of bats in the famous Limestone Caves in Malaya are preyed on by a dark-coloured hawk *Machaerhamphus alcinus* Westerman which appears to feed entirely on bats and swifts. A snake *Elaphe taeniura ridleyi* (Butler) which inhabits these caves also specializes in a diet of bats (A. L. Butler 1899, *J. Bombay nat. Hist. Soc.* **12** : 424-6).—EDS.]

23. *GAMBUSIA* AND MOSQUITO CONTROL

(*With a text-figure*)

Gambusia is the famous ' Top minnow ' that has been very widely used in anti-malarial measures in different parts of the world. It was imported into India about half a century ago from Italy and Thailand and is flourishing today at different parts of the country (Hora & Mukerji 1953).



Gambusia affinis holbrookii (Girard)

Myers (1965) in a recent article entitled ' *Gambusia*, the fish destroyer ' has shown that *Gambusia* is a very dangerous fish to introduce into a place where it does not occur naturally, and is little or no better as a mosquito destroyer than other less dangerous species. Observations made at San Jose, California, during the last seven years (Myers 1965) have proved that *Gambusia* in a new habitat is destructive, not only to fishes of similar size but even to much larger fishes, whereas in its natural habitat it is kept in check by its natural enemies, and smaller fish have evolved a defence against it. As to the damage *Gambusia* has already caused Myers reports thus :

' In certain of our southwestern streams, the native *Poeciliopsis* is gone ; *Gambusia* was introduced. In the canals of Bangkok, Thailand, the common native *Aplocheilus panchax* is now rare and the unique little *Phenacostethus* (known only from there) has disappeared ; *Gambusia* is common. In the creeks around Laguna de Bay, in the Philippines, *Gulaphallus* is gone and *Gambusia* reigns. In the lower Nile, the native *Micropanchax schoelleri* cannot be found, but *Gambusia* is common.'

Even though we have no record of the damage caused to our fish fauna by the introduction into India of *Gambusia* the Public Health authorities would do well to be cautious and abandon further propagation of *Gambusia affinis affinis* (Baird & Girard) and *G. a. holbrookii* (Girard) for malaria control in India.

It may be noted that Poeciliidae, to which *Gambusia* belong, are closely related to the Cyprinodontidae of which five species, namely *Aplocheilus panchax* (Ham.), *A. lineatus* (C. & V.), *A. blocki* (Arnold), *Oryzias melastigma* (McClelland), and *Asphanius dispar* (Rüppell), are found in India, and detailed investigations conducted by Hora and Nair, Gravely, Job, John, etc. (see Hora & Mukerji 1953) have already shown that these fishes are as good as larvicidal fishes as any of the exotic species. They are perennial breeders, and *A. lineatus* is remarkable in its occurrence in all types of water such as hill-streams and reservoirs at high altitudes, and in rivers, tanks, and wells of the plains, low-lying paddy fields, swamps, estuaries, and backwaters (Chacko 1949). All these species are known to be easy to breed in the aquarium, and it is worth while trying commercial breeding of them in aquaria to make them available at a nominal cost for anti-malarial work.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA-12
April 20, 1965.

A. G. K. MENON

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24. SEXUAL BEHAVIOUR IN *LYCOSA CHAPERI* SIMON (ARACHNIDA: ARANEIDA)

(*With four text-figures*)

SYNOPSIS

Observations have been made on the sexual behaviour of *Lycosa chaperi* Simon. The act of copulation in this spider is preceded by two distinct behavioural phases, viz. precourtship and courtship. During the precourtship phase the male spider charges its intromittent (palpal)

organ with semen through a process called sperm induction. This unique process involves transferring the spermatozoa from the internal gonadial system to the palpal organ borne by the pedipalp. Sperm induction is followed by a 24-hour rest period. It is suggested that the spermatozoa undergo certain physiological changes during this period.

The courtship period in *L. chaperi* is of comparatively short duration, probably because the male and the female individuals are of similar stature. In a majority of spiders the males are much smaller than the females and thus courtship is a lengthy process. During copulation the male mounts the female from the opposite direction while she lies in a state of catalepsis. The male uses palpal organs alternately for insertion into the female genital opening. The duration of the sexual act may vary from two to forty-five minutes.

INTRODUCTION

Male spiders lack a primary intromittent organ and have developed instead at the apex of each pedipalp a secondary intromittent apparatus called the palpal organ. Prior to copulation the male spider transfers the spermatic fluid from seminal vesicles in its abdomen to the palpal organs by a process known as sperm induction. The female genital organs, located ventrally near the base of the abdomen, are specialized to receive and store the spermatozoa.

This paper records observations on sexual behaviour in *Lycosa chaperi*, which comprises four distinct phases; precourtship, courtship, precopulation, and copulation.

The observations were made in the zoological laboratories of the Panjab University, Chandigarh. The authors are grateful to Prof. G. P. Sharma, Head of the Department, for providing the necessary facilities.

OBSERVATIONS

Precourtship. Precourtship comprises sperm induction in the male, with no corresponding process in the female. Prior to this the males seem incapable of mating and it has been observed that *L. chaperi* males with empty palpal organs make no effort to copulate. This has also been observed by Petrunkevitch (1911) in a Theraphosid spider *Dugesiella hentzi*. Kaston (1948) mentions that 'fullness in the testes' and 'emptiness in the palpal organs' are the probable factors that stimulate sperm induction.

In *L. chaperi* sperm induction was observed in a laboratory cage that consisted of a lantern chimney placed on a petri-dish containing dung-pieces. The males, upon reaching sexual maturity show distinct signs of restlessness and run around within the chimney. Finally, a sheet of web is constructed with one side attached to the wall of the chimney and the other to the bottom. The male then vibrates its abdomen rapidly sideways rubbing it against the web and finally depositing a spermatophore on the sheet web. The abdominal action seems to be correlated with concentration of heavy setae around the genital orifice and presumably produces a tactile stimulation, which causes ejaculation of the seminal fluid. After ejaculation, the male moves slightly backward bringing its palpi below the sheet and applies the palpal organ to the semen, presumably in order to 'suck' the fluid. Contrary to the experience of Petrunkevitch (1911) with *Dugesiella hentzi*, *L. chaperi* males are extremely sensitive to disturbances of any kind during this process.

For approximately 24 hours after sperm induction the males of *L. chaperi* do not attempt to mate. It is possible that during this period the spermatozoa undergo physiological changes in the palpal organ.

Courtship. Montgomery (1903, 1910) mentions the importance of secondary sexual characters in courtship. In *L. chaperi* there is no marked development of secondary sexual characters apart from the conspicuously black tarsi and metatarsi of the front pair of legs.

The courtship period is very short, presumably because the two sexes are of equal strength and build. Petrunkevitch (1911) and Kaston (1936) mention that courtship in spiders exploits the senses most highly developed in them. Kaston (1936) remarks that either or both the senses of sight and touch are involved in the courtship of certain vagabond spiders. It appears that both sight and touch are involved in the courtship of *L. chaperi.* The sense of touch seems to be of greater importance, because males were noticed to attempt mating upon random contact with females.

Savory (1928) and Gertsch (1949) have reported the use of signals through the silken threads of the web during courtship in some spiders. Gering (1953) also observed similar behaviour in three species of *Agelena.* As, however, *L. chaperi* is a ground-dweller, the females do not always spin a web and the approach of the male to the female is direct.

When placed together in a cage, both the male and the female remain inactive for a few minutes. Courtship begins only when the male accidentally comes across the female. Immediately, the male poses with raised body and extended pedipalps (Fig. 1). Slowly he advances towards the female with palpi and front legs elevated and the latter directed towards her (Fig. 2). The metatarsi and the tarsi of the front legs tremble violently during the advance, as if performing a dance. When he reaches close enough to her there is an interplay of the front legs of both. She tries to drive him away, but he overpowers her and climbs on her (Fig. 3).

Precopulation. During precopulation the male establishes contact with the female after proper positioning. The female meanwhile remains passive in a state of catalepsy, involving the entire body especially the legs. As soon as the male establishes contact the female drops to the substratum, with the first and the second pair of legs pointing forward and third and fourth pair pointing backward. The male lifts her body and turns her abdomen slightly with his first pair of legs. After adjust-

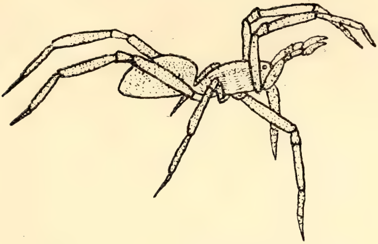

Fig. 1. Position of a male on contact with a female

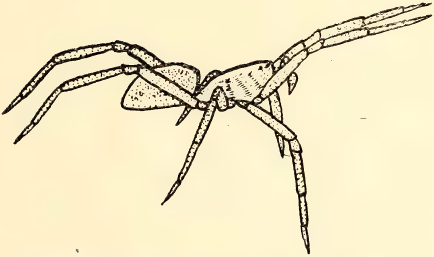

Fig. 2. Posture of a male while advancing towards a female

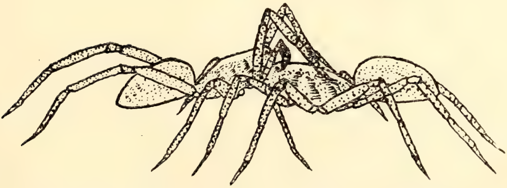

Fig. 3. A male and female in readiness for copulation

ment of the body position his body lies at an angle of about 45° with the long axis of her body (Fig. 4).

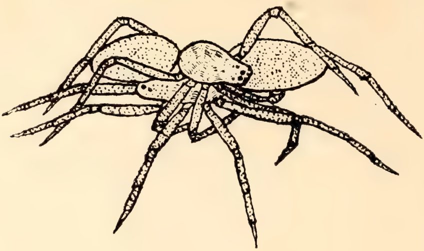

Fig. 4. A male and a female engaged in copulation

There is no resting stage following the positioning phase and copulation follows immediately.

Copulation. In spiders copulation may be defined as the physical contact between the palpal organs of the male and the epigynum of the female.

In *L. chaperi*, immediately after the positioning phase, the male begins to tap the epigynum of the female with his palpi. The number of attempts made before inserting the palpal organ into the female opening vary. Finally, contact is established by a slight twist of the palpus and further adjustment in the body position (Fig. 4). The palpal organ fits into the furrow-sac at the anterior end of the epigynal opening. The furrow-sac can be compared with the coupling cavity in Agelenid spiders (Gering 1953). The right and left palpal organs are used alternately for insertion into the female organ. During this act the male jerks his abdomen and hind legs vigorously and taps the abdomen of the female with his forelegs. The duration of copulation in *L. chaperi* may vary from two to forty-five minutes.

A single female has been observed to mate with as many as 10 males on the same day, but a male after one mating avoids contact with females.

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PANJAB UNIVERSITY, G. L. SADANA
CHANDIGARH (PUNJAB),
April 7, 1965.

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25. A NEW SPECIES OF *EPICROSEJUS* BERLESE (ACARINA: EPICROSEJIDAE) FROM SITALA IN WEST BENGAL

(*With two plates containing ten figures*)

The genus *epicrosejus* Berlese is, at present, represented by five species: *angelioides* Berlese (1904) from Java, *E. seioides* Berlese (1910) from Java, Tahiti (Berlese 1918), Marquesas Islands (Vitzthum 1935), *E. scutatus* Berlese (1923) from Sumatra; *E. zimmermani* Trägårdh (1953) from Mangareva Islands, *E. porosus* Domrow (1956) from Green Ant Islands. The species, described below from India, is the second record of the genus from the Indian Sub-Region.

Epicrosejus abinashi sp. nov.

Female. The dorsum (length 0·684 mm.; width 0·540-0·558 mm.) is partly covered by the anterior, median, and posterior shields. All dorsal setae are pilose. The anterior dorsal shield is triangular, a little wider than long, and bears about thirty-one pairs of setae. The anterior shield is surrounded by inter-scutal membrane except at the anterior end (Plate I, Fig. 1). The median dorsal shield is somewhat rectangular in shape and bears twelve pairs of setae (omitting the setae on the 'cuneiform areas'). The anterior and posterior 'cuneiform areas' are provided with five and two setae each, respectively. The median shield is entirely surrounded by inter-scutal membrane. The posterior dorsal shield consists of two shields with a median longitudinal groove bearing no setae, which is continuous with a similar ventral strip behind the anus. Each of the two posterior shields bears ten to eleven setae. The posterior shield does not extend to the margin of the body except at the posterior edge.

The tritosternum has a basal part and a pair of pilose laciniae. It is flanked by variable number of processes. The most distinctive feature of the intercoxal region is shown in Plate I, Figure 2. The ventri-anal shield is large and provided with a number of setae. The postero-lateral margin of the ventri-anal shield carries two pairs of projections, the median pair much shorter than the lateral pair. Each lateral projection terminally bears a very long seta, 0·224-0·230 mm. in length; the remainder of the chaetotaxy of this projection is composed of short setae as arranged in the figure. Each median projection carries a seta, 0·144-0·154 mm. in length. Ventrally, the inter-scutal membrane bears about eight pairs of setae, some of which are situated on a distinct sclerite (not shown in the figure). The stigma lies between coxae III and IV; the peritreme extends beyond coxa 1. The peritremetal shield is anteriorly coalesced with the dorsal shield whilst its post-stigmatal extension partly encircles coxae IV.

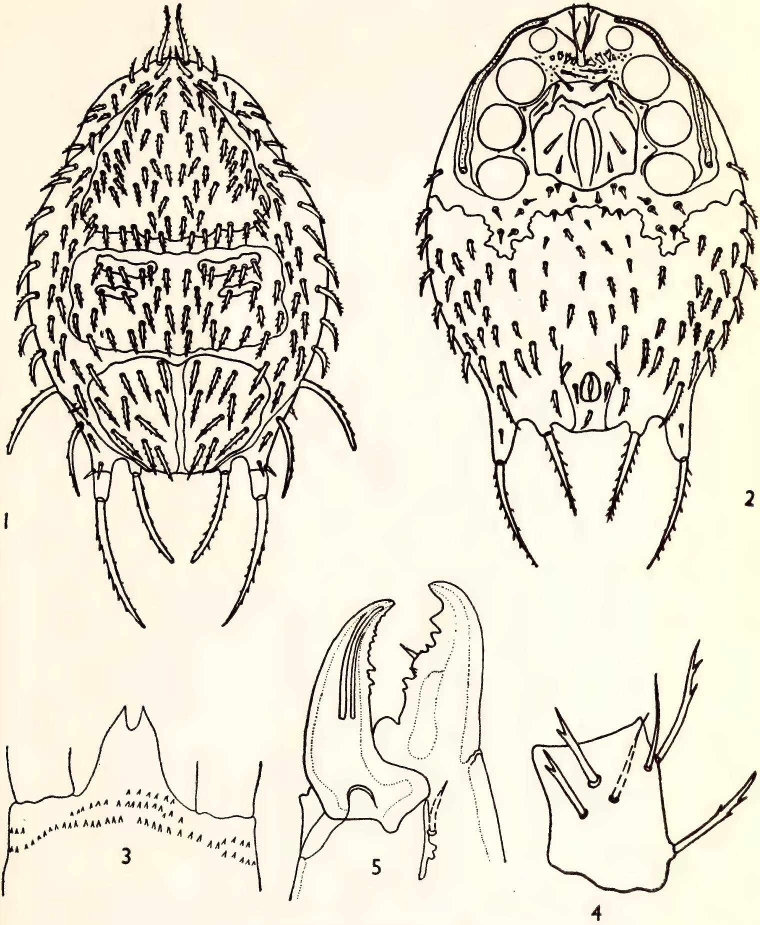
The tectum is two-pronged and provided with numerous small spiniform processes at the base (Plate I, Fig. 3). The trochanter, femur, and genu of the pedipalp (Plate I, Fig. 4) are provided with two, five, and six setae respectively. The apotele of tarsus is two-pronged. The dentition of the chelicera is shown in Plate I, Figure 5. The gnathosoma very characteristically lacks capitular setae and is provided with numerous spiniform processes which are arranged in a pattern as shown in Plate II, Figure 6. The rostral, external posterior, and internal posterior rostral setae are 0·040, 0·036-0·040, and 0·052-0·060 mm. long respectively. Seven rows of deuto-sternal denticles lie on the ventral groove of the gnathosoma.

Tarsus I (*c.* 0·164 mm. in length) bears terminally a pair of long setae (0·076-0·080 mm.) and lacks an ambulacrum (Plate II, Fig. 7). Tarsi II-IV terminate in relatively long pretarsi provided with pulvilli and claws.

Male. The structures and chaetotaxy of the dorsum (length and width of the slightly distorted specimen have not been measured) are essentially the same as those of the female (Fig.8).

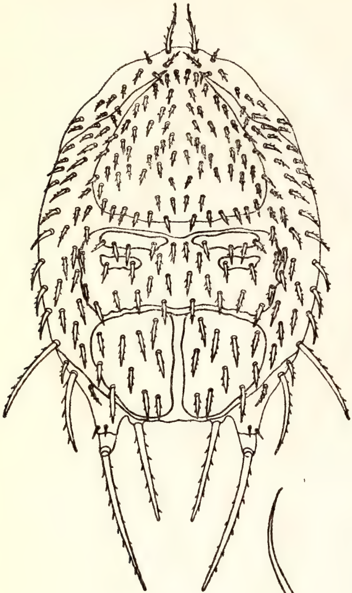
The venter resembles the female's, excepting the 'sterniti-genital' area. The genital orifice lies between sternal setae I and II, and is covered by a circular disc (Plate II, Fig. 9). The anterior margin of the sterniti-genital shield is ill defined and its posterior end is situated at the level of coxae IV. It bears seven pairs of setae, indicating that it is composed of the sternal, metasternal, and part of the ventral shields. The ventri-anal shield has the same facies as that of the female, and the terminal setae of the median and lateral projections measure 0·142-0·152 and 0·204-0.216 mm. in length, respectively.

The structures of the tectum and the pedipalp are apparently the same



Epicrosejus abinashi sp. nov.

Figs. 1-5. Female: 1. dorsum; 2. venter; 3. tectum; 4. genu of pedipalp; 5. chelicera



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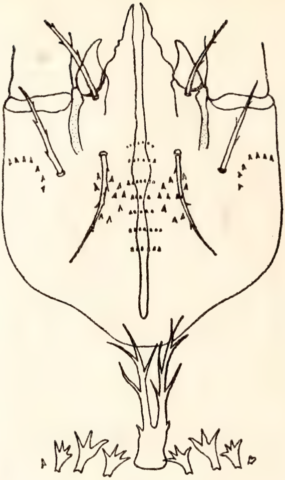

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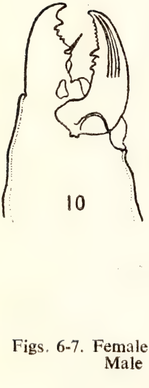

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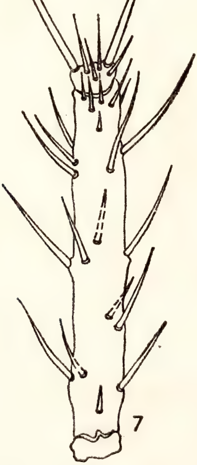

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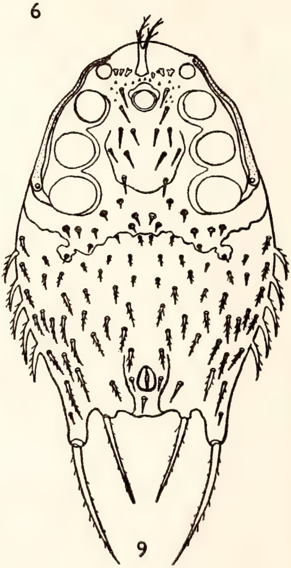

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Epicrosejus abinashi sp. nov.

Figs. 6-7. Female: 6. venter of gnathosoma; 7. tarsus of leg I. Figs. 8-10. Male: 8. dorsum; 9. venter; 10. chelicera as in the female. The chelicera is shown in Plate II, Figure 10. The rostral, external posterior, and internal posterior rostral setae are 0·036-0·040, 0·040, and 0·052-0·056 mm. long respectively. The capitular seta is absent.

Tarsus I is 0·152-0·160 mm. long and terminally bears a pair of long setae, 0·076-0.080 mm. long. It lacks an ambulacrum. Tarsi II-IV have ambulacra.

Locality: The holotype female, allotype male, and thirteen paratype females from rotten straw (Sitala, near Sonarpur, 24 Parganas District, West Bengal, S. K. Bhattacharyya, 5.10.1963), are deposited in the collection of the Zoological Survey of India, Calcutta.

Remarks: *Epicrosejus abinashi* sp. nov. is closely related to *E. porosus* Domrow, 1956 and *E. zimmermani* Trägårdh, 1953. The new species may be readily distinguished from *E. porosus* by the number and disposition of the setae on the dorsum, the shape and setation of the ventri-anal shield, the distinctive features of the sterniti-genital shield and its setation in the male, and the dentition of the chelicera. The new species is also readily separated from *E. zimmermani* by the presence of the four 'cuneiform areas' and the total absence of any longitudinal suture on the median shield, the posterior shield lacking fusion in the middle, the shape and setal pattern of the ventri-anal shield, the shape of the genual setae on the palp, and the dentition of the chelicera.

This species is named after the author's father, Professor Abinash Ch. Bhattacharyya.

ACKNOWLEDGEMENTS

I am indebted to Dr. D. N. Raychaudhury for his keen interest in the work, to Prof. J. L. Bhaduri for giving me the necessary facilities in his Department.

This investigation was supported by a Senior Research Fellowship from the Council of Scientific and Industrial Research of India.

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF CALCUTTA,
CALCUTTA,
February 19, 1965.

S. K. BHATTACHARYYA[1]

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[1] Present address: Zoological Survey of India, Calcutta 20.

26. *ODONTOTERMES OBESUS* (RAMBUR) [TERMITIDAE : MACROTERMITINAE] AT 4500 FT. IN KUMAON HIMALAYAS

On 14 October 1962 in the course of geological exploration in the Binsar area of the Kumaon Himalayas (Almora District, Uttar Pradesh), I came across an active mound of the termite *Odontotermes obesus* (Rambur) at Siya village (4500 ft. alt.; *c.* 29° 40′ N., 79° 55′ E.); about 10 miles NE. of Binsar.

The mound made of brownish earth was about one metre high with a number of narrow buttresses all around. It was the sole mound seen by me in that area and was situated in a grassy patch on a hill-slope and near two small pine trees. The rock in that area is mostly ferruginous quartzite and pink slates. I collected from the mound some soldiers and workers which have been deposited in the Zoological Survey of India and were identified by Mr. O. B. Chhotani as *Od. obesus.*

I am informed that this is the common mound-building termite in the plains and foothills practically all over India, but its occurrence at the present high elevation is uncommon, though records from south India are available (Holmgren & Holmgren 1917, pp. 146-149) up to 4500 ft. in the Shevaroy Hills and 4600 ft. in the Bababudin Hills.

DEPARTMENT OF GEOLOGY,
PATNA UNIVERSITY,
PATNA,
April 10, 1965.

GANPAT SINGH ROONWAL

27. STUDIES ON THE MORPHOLOGY AND TAXONOMY OF INDIAN BOSTRYCHIDAE

VI. A NEW SPECIES OF THE GENUS *BOSTRYCHOPSIS* LESNE FROM INDIA (COLEOPTERA : BOSTRYCHIDAE)

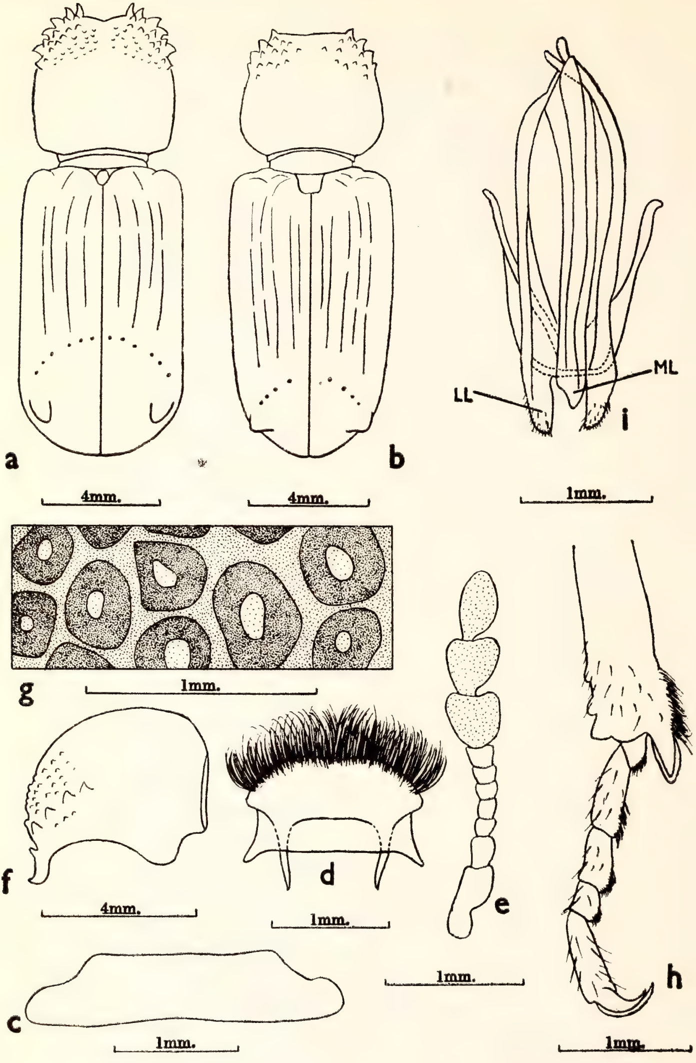
(*With one plate*)

Bostrychopsis roonwali sp. nov.

MALE

Colour : Piceous; antennae, palpi, and tarsi fusco-piceous.

Head strongly convex, densely, finely punctate, with a narrow longitudinal line at middle and short, fine, longitudinal, parallel carinae on occiput, pubescence consisting of short, recumbent, whitish hair; clypeus convex, densely, coarsely punctate, densely clothed with short semi-recumbent, yellowish white hairs, arcuately emarginate anteriorly; clypeal suture depressed at middle, obscure at sides; labrum subtruncate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Bostrychopsis roonwali sp. nov.

a. Male, dorsal view; *b.* Female, dorsal view; *c.* Clypeus, dorsal view; *d.* Labrum, dorsal view; *e.* Antenna; *f.* Pronotum, side view; *g.* Elytral punctures; *h.* Hind tibia (a portion) and tarsus; *i.* Male genitalia, dorsal view: LL—lateral lobe; ML—median lobe and densely pubescent anteriorly, finely, indistinctly punctate. Antennae 10-segmented; antennal club sparsely pubescent, first and second segments of antennal club subtriangular; third oval; antennal club longer than funicle (1·2 : 0·9 mm.).

Pronotum strongly convex, distinctly longer than wide (5·5 : 4·9 mm.), widest behind middle; sides broadly rounded posteriorly; converging anteriorly, with a long, stout, unciform horn at apical angles; anterior margin truncate; postero-lateral angles broadly rounded; surface densely coarsely imbricate—punctate on basal half, densely, irregularly dentate on apical half, the teeth broad, semi-erect, variable in size and rasp-like, with six larger ones on each side along antero-lateral margin; pubescence consisting of short, recumbent, inconspicuous, whitish sparse hair.

Scutellum subquadrate, rounded at apex, finely, sparsely punctate.

Elytra strongly convex, more than one and a half times as long as pronotum (9·6 : 5·5 mm.), sinuate at base; sides subparallel, slightly expanded posteriorly, conjointly, broadly rounded at apices; surface densely, coarsely, deeply, irregularly punctate, punctures smaller on sides. Elytral vestiture consisting of short, recumbent, inconspicuous, whitish hair. Apical declivity obliquely deflexed, with a small, blunt tubercle on each side along lateral margin; sutural margins slightly, broadly, uniformly elevated on apical declivity.

Ventral surface: Piceous, densely, finely punctate, densely clothed with moderately long, recumbent, yellowish hairs; last visible abdominal sternite rounded and densely pubescent at apex.

Genitalia as figured (Plate, i), elongate, subparallel. Median lobe bluntly pointed at apex, shorter than lateral lobes, which are rounded and moderately pubescent at apices.

FEMALE

Differs from the male as follows: Clypeus less densely pubescent; pronotum without horns at apical angles; tubercles on apical declivity of elytra less prominent; last visible abdominal sternite subtruncate at apex.

Length: 14·5-15 mm.

Breadth: 4·7-4·8 mm.

TYPE-LOCALITY. Lachhiwala (Dehra Dun District, Uttar Pradesh, India).

TYPE-HOST. *Shorea robusta* Gaertn. f.

TYPE MATERIAL. *Holotype*, male: Lachhiwala (Dehra Dun District, Uttar Pradesh, India), 25. viii. 1962, K. Rai. *Allotype*, female: same data as for holotype. *Paratypes*, 2: same data as for holotype. Material deposited in the Entomological Collection, Forest Research Institute, Dehra Dun.

GEOGRAPHICAL DISTRIBUTION. Known only from the type locality.

COMPARISON. This species is allied to *B. bengalensis* (Lesne), from which it is distinguished as follows: pronotum widest behind middle; larger size; each elytron with a small, blunt tubercle on apical declivity, tarsi shorter.

I name this species after Dr. M. L. Roonwal, Director, Zoological Survey of India, in token of the high regard in which I hold him.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA 12,
May 14, 1965.

KULDIP RAI
Asst. Zoologist

28. A STUDY OF THE LARVAL STAGES OF *BRANCHINELLA BISWASI* K. K. TIWARI (CRUSTACEA: BRANCHIOPODA)

(*With two plates*)

MATERIAL

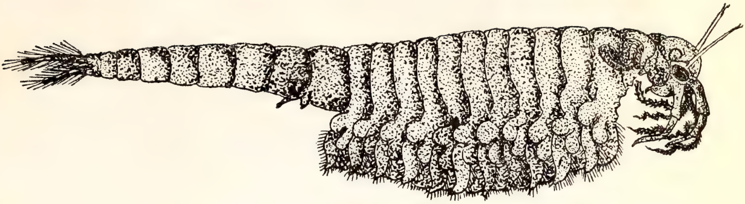
Adult male and female specimens of the shrimp *Branchinella biswasi* (Plate I) were netted from Sambhar Lake, Rajasthan, in the month of August 1962 after plentiful rain and were released in an empty cemented salt pan in which rain-water had collected. After a few days the females were examined and were found to have large ovisacs full of eggs. The females averaged 27 mm. in length and 6 mm. in breadth with the ovisac extending to the 4th abdominal segment. The size of the males recorded prior to their release in the pan was 20 mm. in length and 4 mm. in breadth at the cephalic region. The animals became senile and died after a short time leaving floating masses of light brown eggs.

As the breeding behaviour was not observed it was not possible to state whether the shrimps copulated in the pan and, if so, whether the eggs were fertilized or not. The eggs had shells and averaged 0·10 mm. in diameter.

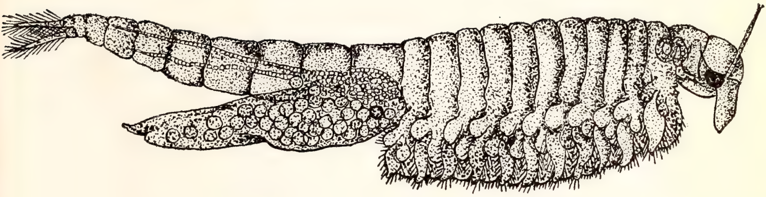
HATCHING OR SEEDING

After a lapse of one year the eggs were sprinkled over the surface of clear fresh water in a glass trough and left undisturbed. The room temperature varied between 28° to 38° C. in twenty-four hours. The larvae were collected every twelve hours and examined.

The *Branchinella* undergo few changes during their larval development, due to their simple anamorphic growth by which the body and the appendages are completed and brought to adult condition through successive stages. The *Branchinella* are thus of interest as they show



MALE



FEMALE

Branchinella biswasi K. K. Tiwari—Adult

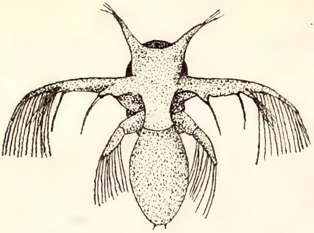


Fig. 2

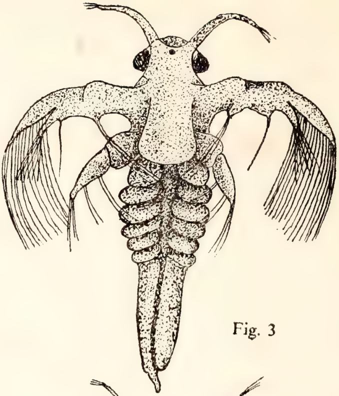


Fig. 3

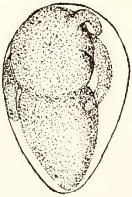


Fig. 1

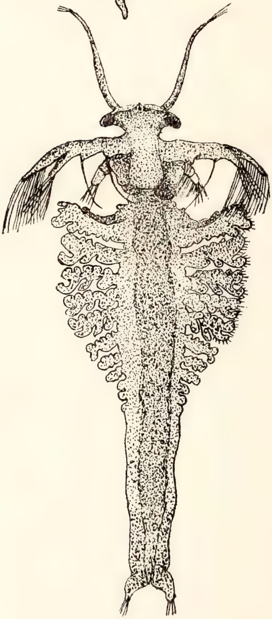


Fig. 4

Branchinella biswasi K. K. Tiwari

Fig. 1. Unhatched prolarva 8 hours after seeding; Fig. 2. Newly hatched nauplius larva at 12 hours after seeding; Fig. 3. 24-hour old metanauplius larva; Fig. 4. Advanced metanauplius larva at 48 hours

development from the simple nauplius to the adult. The development is accompanied by specialization of the post-gnathal appendages for swimming purposes. The antennae change from biramous stenopoda to phyllopoda at the end of the process.

Observations

Unhatched prolarva

Plate II, Fig.1 shows the unhatched prolarva 8 hours after seeding in fresh water at room temperature. It is still encased within the transparent shell membrane, the body of the post embryo is distinguished into cephalic and trunk regions by a slight constriction situated approximately $\frac{1}{3}$ distance from the summit. A pair of rudimentary first appendages are visible as small stumps. The entire structure is a congregation of cells aggregating mostly at the margins of the prolarva.

Nauplius larva

The newly hatched larva is a typical Branchiopod nauplius. Plate II, Fig. 2 shows it at 12 hours after seeding at room temperature. Its size ranges from 1·27 mm. to 1·34 mm. The anterior region is segmented and posteriorly the trunk ends in a median anal opening. It has three pairs of cephalic appendages—a pair of antennules, antennae, and a pair of mandibles. There is a conspicuous median simple eye and rudiments of maxillae are discernible below the mandibles, and a large labrum. The antennae are the main swimming appendages. The larvae swim vigorously on the water surface in search of food particles and are phototropic. The alimentary canal is clearly visible with dark particles all along its length.

Metanauplius larva

The 24-hour old larva (Plate II, Fig. 3) is about 2·5 mm. in length. Internal compound eyes are visible, due to their pigmentation. The antennules are still short and unsegmented. The antennae and the mandibles are reduced in length. The post-gnathal lobes are very well developed and the maxillary gland is visible below the mandibles. The posterior part of the body is greatly lengthened and bears six pairs of well-developed ' phyllopodia ' type legs in addition to five pairs of leg rudiments. At the terminal end there is a protuberance on the left side which develops into the caudal furcum.

Advanced metanauplius larva

At 48 hours (Plate II, Fig. 4) the metanauplius larva measures 3·5 mm. in length. The thoracic appendages are progressively developed from the cephalic to the caudal end in a regressive sequence. Each of the phyllopoda is now biramous, anterior thoracic appendages are clearly divisible into a bilobed exopodite and a broad segmented endopodite and an epipodite at its base. All the segments of the appendages bear spines. The antennae now tend to lose their typical stenopodial biramous structure adapted for swimming and appear as broad phyllopods as in the adult. The caudal furci are represented by a pair of stumps with scarce bristles.

Juvenile stage

The juvenile attains a length of 4 mm. at the completion of larval development. It more or less resembles the adult except for the difference in size and the absence of the ovisac or a pair of penial structures. The sex of the animal is not ascertainable at this stage. The eyes, sessile in their first appearance, now become pedunculated. The lateral lobes on which they are located lengthen and separate from rest of the head region.

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The author is grateful to Dr. K. K. Tiwari for his kindness in identifying the specimens obtained by him for the purpose of these observations.

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29. FURTHER RECORDS OF MARINE WOOD-BORERS (TEREDINIDAE: MOLLUSCA) FROM BOMBAY WATERS

Shipworms of the family Teredinidae are fairly common in Indian waters and nine species have been recorded from the Bombay coast (Palekar *et al.* 1964). In the course of a systematic study of the incidence and control of marine wood-borers at Bombay, two additional species hitherto unrecorded from the Bombay coast were collected and are briefly reported in this note.

During March 1964, a single specimen of *Bankia nordi* Moll 69 mm. long (terminal portion of the pallets missing) was collected from a destroyed timber piece at the Sewri timber pond. On 2 November 1964, four specimens of *Teredo clappi* Bartsch (all ovigerous females, ranging from 17 mm. to 21 mm. in length) were collected from the base of a living mangrove tree at Cuffe Parade. The holes on the mangrove stem were situated 7 to 9 in. above mud level and about 36 in. below high water mark. Subsequent attempts to procure additional specimens of the above two species have not been successful.

B. nordi has been recently recorded from Pamban (Rameswaram) (Nair 1962) and the present record extends its distribution to the west coast of India. Singapore, Indo-China, Sumatra, and New Guinea are the other localities from which this species has been reported.

Certain borers belonging to the genera *Teredo*, *Bankia*, and *Bactronophorus* are known to attack living mangroves (Roonwal 1954, Ganapati & Rao 1959), though *T. clappi* has not so far been known to have this tendency. This species, known from Florida, Bermuda, West Indies, the Caribbean coast (canal zone), Virgin Islands, and Puerto Rico, has not so far been recorded from the Indian coast. However, Turner (personal communication dated 3-1-1965) is of the view that *T.* (*Zopoteredo*) *trulliformis* Miller reported from Visakhapatnam (Nagabhushanam 1955) and *T.* (*Coeloteredo*) *renschi* Roch reported from Madras (Nair 1964) are synonymous with *T. clappi*. If this view is accepted *T. clappi*, with the present record from Bombay, would appear to be not so very rare in Indian waters.

The author is indebted to Dr. (Miss) Ruth D. Turner for help in identification of the species and to Shri K. H. Alikunhi for guidance and encouragement during the course of this study and for critically going through the manuscript.

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30. *OZOBRANCHUS BRANCHIATUS* (MENZIES, 1791) (HIRUDINEA : ANNELIDA) FROM PULICAT LAKE, SOUTH INDIA

As revised by the present author (1954) the genus *Ozobranchus* de Quatrefages, 1852 which includes the rather rare gill-bearing leeches, has six species all of them generally ectoparasitic on chelonians. Of them, only *O. shipleyi* Harding, *O. papillatus* Kaburaki, and *O. polybranchus* Sanjeeva Raj were then recorded from India. Subsequently (1959), the author recorded *O. margoi* Apathy, more than a thousand specimens, collected from *Eretmochelys imbricata* (Linnaeus) on the coast at Ennore (12 miles north of Madras). Recently Ghosh *et al.* (1963) recorded *O. branchiatus* (Menzies) from an unidentified turtle on Pirotan Island, Gulf of Kutch.

On 14th October 1964 some post-graduate students and I, while collecting on Pulicat Lake, a large brackish-water lake north of Madras, found two large dead *Chelonia mydas* (Linn.) on the shore. These two turtles were said to have been captured the previous day from the lake, about half a mile from the sea. Both were infested heavily, on the carapace as well as the plastron, with large-sized *Chelonobia testudinarium* Linnaeus. One of the turtles carried on its plastron, just adjacent to the *Chelonobia* patch, a large cluster of leeches recently dead but still quite fresh, gorged with the host blood. They were removed with a scalpel into strong alcohol, about one hundred of them, all belonging to *Ozobranchus branchiatus* (Menzies, 1791).

All these leeches were light flesh-coloured except the posterior part of the abdomen, which was blood-red due to their blood-gorged gut. They ranged from 2 mm. to 9 mm. in total length (inclusive of suckers) and about 1 mm. to 3 mm. in width (inclusive of gills). The younger specimens (from 2 mm. to 3·5 mm. in total length) clearly showed a pair of dark eye-spots on the dorsum of the neck just over the anterior sucker, which really ought to be segment IV. The anterior sucker in most diagrams of this leech has been figured as cup-shaped, but in the present collection some of the younger specimens, up to 2·5 mm. in total length, show the anterior sucker as well spread-out and circular, very much like the posterior sucker but about half its diameter and rather thinner and more translucent. The rim of the anterior sucker is so thin that soon after death it curves inwards so as to look like a cup. Ghosh *et al.* have erroneously called this the mouth; the mouth is a small circular opening, a little anterior to the centre of the sucker, often not easily conspicuous to the naked eye (Sanjeeva Raj & Penner 1962).

Additional information about this leech including a description of the annulation of the neck is given by Sanjeeva Raj & Penner (1962). The presence of eyes in younger forms and their apparent absence in adults is due to their sinking into the parenchyma (MacCallum & MacCallum 1918, Sanjeeva Raj & Penner 1962). The specimens from Pirotan Island showed no eyes, but in the present collection eyes are visible in individuals up to a total length of 3·5 mm. and, even after that stage, they can be demonstrated either by clearing or by pressing the eye region strongly between two slides.

The host for the Pirotan Island recovery was not identified. Apart from this *O. branchiatus* has so far always been collected from the Green Turtle, *Chelonia mydas* (Linn.). It is interesting to note that when the host gets into brackish waters, both the host and its epizoic forms like *Chelonobia* and this leech tolerate prolonged exposure to lowered salinities. Members of this genus have been collected from estuarine waters before, namely *O. polybranchus* Sanjeeva Raj from the Vellar Estuary at Porto-Novo (1951). These leeches can live for some time on the host after the death of the host and can tolerate dessication to some extent as they have a mucous exterior. In most earlier collections, this leech has been found associated with either bruised parts or tumorous growths on the host. Similarly, this time it was found around patches bruised by the attachment of *Chelonobia.* It is obvious that such oozing patches on the horny exterior of the chelonians provide an easy blood meal.

Ozobranchus branchiatus (Menzies) is now known from the Tropical Pacific, Australia, Isles of Ogaswara (Japan), Florida, Sarawak, and the east and west coasts of India. Therefore, its range of distribution though broadly confined to the tropics and subtropics is now extended throughout the Indian coast and even into brackish waters. The leech seems to be rather host-specific to *Chelonia mydas* (Linn.).

MacCallum & MacCallum (1918), who obtained egg-capsules of this leech from Florida, noted that just-hatched young ones may be about 1·2 mm. in total length. Many individuals of the present collection measured about 2·0 mm. indicating that these leeches were probably recently hatched, so that we may take it that they breed in about the month of October in the Pulicat Lake area.

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31. STUDIES ON THE CHAETOGNATHA OF THE INDIAN SEAS. PART VIII. ON THE OCCURRENCE OF *SAGITTA FEROX* DONCASTER AND *S. HEXAPTERA* D'ORBIGNY IN THE WATERS OFF VISAKHAPATNAM[1]

During the course of our work on the plankton of the waters of the Visakhapatnam coast (1952-58), 16 species of Chaetognaths have already been reported to occur here (refer previous Parts I-VII). In the present note the occurrence of two more species namely *S. ferox* and *S. hexaptera*, recorded for the first time from the waters off Visakhapatnam, are dealt with.

Sagitta ferox Doncaster

There has been some confusion in the literature with regard to the proper identification of this species. As *S. ferox* bears a very close resemblance to *S. robusta* Doncaster, there have been attempts to synonymise the two species. Ritter-Zahony (1911) placed *S. ferox* as a synonym of *S. robusta* and similarly Burfield & Harvey (1926) merged the two species on the grounds of similarity of head armature. However, Thomson (1947) kept them separate and has recorded certain constant differences in body proportions and in the shape of seminal vesicles between the two species. Besides, in *S. robusta* the head and collarette are broader than in *S. ferox* and the former attains a larger size than the latter. Doncaster (1902), also, found similar differences between the two species occurring here as shown in the following table. For comparison 'Warren' material from Thomson (1947) is added just to show the range of variation in the species.

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[1] Read at the seminar on 'Some Aspects of Plankton Research' held at Porto Novo in March 1964.

Tokioka (1956) recorded *S. ferox* from the central part of the Indian Ocean. In the waters of the Lawson's Bay it is present from February to May and occurs in fewer numbers than *S. robusta*.

	'Warren' material		*Lawson's Bay material*	
	robusta	*ferox*	*robusta*	*ferox*
Width ..	6·1-6·6	5·5-5·8	6·0-8·7	4·4-6·74
Width of head ..	9·4-11·4	7·7-8·3	8·3-10·0	8·7-12·0
Length of anterior fin ..	25·5-30·4	21·1-22·7	28·0-30·98	22·2-24·0
Length of posterior fin ..	25·4-30·8	25·0-27·8	26·3-28·5	26·8-27·7

NOTE. The measurements are percentages of the total length of the body.

S. hexaptera d'Orbigny, 1843

This is probably the largest species found in the present collection and has been obtained from the plankton during March to May, but absent in other months. The following are the average measurements of the adult specimens from this coast:

Maximum length ..	28 mm.	
Tail segment ..	17·9 to 21·3	(% total body length)
Width of the head ..	5·2 to 6·0	do.
Anterior fin ..	12·5 to 14·3	do.
Posterior fin ..	21·87 to 23·3	do.
Distance between anterior and ventral fins ..	13·0 to 14·6	do.
Percentage of posterior fin in front of tail septum ..	more than 60%	
Jaws ..	7·0 to 8·0	
Anterior teeth ..	2·0 to 4·0	
Posterior teeth ..	3·0 to 7·0	

ACKNOWLEDGEMENTS

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32. STUDIES ON THE CHAETOGNATHA OF THE INDIAN SEAS. PART IX. DIURNAL VERTICAL MIGRATION OF SOME SPECIES OF CHAETOGNATHA IN THE WATERS OFF VISAKHAPATNAM [1]

INTRODUCTION

Diurnal vertical migration of the planktonic organisms in the surface layers of the sea is a well known phenomenon. The works of Michael (1919), Russel (1931), and others have confirmed the occurrence of vertical migration and they attribute this phenomenon mostly to the effect of light on the plankton. More recently Moore *et al.* (1953) and Owre (1960) have established some relationship between the vertical distribution and temperature.

The present observations on the vertical migration of Chaetognatha are based on the analysis of 94 samples of plankton collected at hourly intervals both from the surface and at different depths during the drifting cruises Nos. 2, 7, and 31 conducted in the waters off the Visakhapatnam coast. A Nansen-type of closing net was used for vertical hauls of plankton. In the following account the vertical distribution of 4 species of Chaetognatha, namely *Sagitta enflata* Grassi, *S. neglecta* Aida, *S. serratodentata* Krohn, and *Pterosagitta draco* Krohn, is described (see Parts I-VIII for other details of distribution in space and time).

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[1] Formed part of the Doctoral thesis submitted by the author to the Andhra University.

TABLE I

VERTICAL DISTRIBUTION OF THE CHAETOGNATHA *Sagitta enflata*

(Summary of the data from Cruises No. 2, 7 and 31)

Cr. No.	Range in feet	DAY							NIGHT					
		6/7	8/9	10/11	12/13	14/15	16/17	18	19/20	21/22	23/0	1/2	3/4	5
2	surface	68	12	11	—	—	—	—	—	—	37	74	—	—
7	do.	—	141	11	*	—	*	—	—	—	—	—	—	—
31	do.	14	2	67	—	18	—	29	—	*	25	2	22	26
2	100/0	—	—	5	—	—	—	—	—	—	—	—	20	—
7	150/0	x	2	—	29	—	14	—	—	7	5	18	18	—
31	240/0	14	—	—	—	—	18	25	28	30	—	—	16	31
7	350/150	3	4	—	—	—	1	—	—	2	1	4	3	x
2	400/250	12	—	45	—	—	—	—	—	—	40	33	—	—
7	500/300	x	—	4	—	—	—	—	—	x	5	x	—	x
2	550/450	—	—	—	—	x	—	—	—	—	—	—	—	—

x indicates a haul in which this species was not found.

* indicates swarms

Cr. No.	DAY			NIGHT		
	No. of hauls	Range in feet	Total	No. of hauls	Range in feet	Total
2	6	surface	168	3	surface	184
	3	225/100	83	..	..	..
	3	400/200	58	3	450/250	113
	1	550/450	0	..	..	..
7	4	surface	*	..	..	..
	4	150/0	29	8	150/0	43
	3	300/0	17	..	..	..
	4	350/150	12	8	350/150	18
	2	500/300	4	4	500/300	5
31	6	surface	200	8	surface	*
	..	..	..	4	120/0	35
	4	240/0	82	6	240/0	163
	2	600/0	52	..	..	..

VERTICAL DISTRIBUTION

Sagitta enflata (Table I)

Michael (1911) describes this species as strictly epiplanktonic. According to Thiele (1938) the distribution of *S. enflata* is mostly confined to the upper zone, extending between 0-50 metres, and it might be present in waters below 400 metres. Owre (1960) has reported the occurrence of diurnal vertical migration for this species in the Florida current and found most of the forms occurring in the upper 200 metres.

Off the Waltair (Visakhapatnam) coast *S. enflata* is the most widely distributed of all the species of Chaetognatha. Most of the forms were collected in the upper 500 feet. A study of the Table I reveals the interesting fact that there is a gradual decrease (see average values) in numbers of this species with increase in depth both during the day and night.

S. neglecta (Table II)

This is next only to *S. enflata* in abundance on this coast. Michael (1911) found this form to be a typical surface-dwelling Chaetognath and he never obtained it in open or closed vertical nets off San Diego.

During Cruise No. 2, this species showed a distinct increase in number with depth during the day and surface concentrations in the night, while the reverse was the case in the material collected during the cruises No. 7 and 31. Like *S. enflata* this also is a surface-dwelling form and perhaps does not show any large scale vertical diurnal migration on this coast.

S. serratodentata (Table III)

Fowler (1906) considers this form to be surface-dwelling and also mesoplanktonic. Owre (1960) found this form oddly distributed like *Sagitta enflata* and *S. hexaptera* in the waters of the Florida current.

S. serratodentata occurs in these waters only from January to August and is considered as an indicator species of the northerly current flowing past this coast during the above period. From the data presented in Table III it shows a scattered distribution at different depths both during the day and night. However, the average values for the day and night during the cruise No. 7 indicate an instance of vertical diurnal migration. But in the material of the cruise No. 31 higher concentration of this species was found in the surface waters both during the day and night.

Pterosagitta draco (Table IV)

Fowler (1906) considers this form to be both neritic and oceanic. Burfield & Harvey (1926) found this form to be distinctly epiplanktonic

TABLE II

VERTICAL DISTRIBUTION OF THE CHAETOGNATHA *Sagitta neglecta*
(Summary of the data from Cruises No. 2, 7 and 31)

Cr. No.	Range in feet	DAY							NIGHT					
		6/7	8/9	10/11	12/13	14/15	16/17	18	19/20	21/22	23/0	1/2	3/4	5
2	surface	x	x	1	—	x	—	—	—	—	—	—	—	—
7	do.	—	x	x	*	—	*	—	—	—	—	—	—	—
31	do.	x	—	16	—	9	—	x	—	x	3	x	x	x
2	100/0	—	—	x	—	—	—	—	—	—	—	—	—	—
7	150/0	x	x	—	—	—	3	—	x	x	13	9	x	—
31	240/0	x	—	—	—	—	x	—	x	13	—	—	x	1
2	180/150	—	—	—	—	—	—	—	x	—	—	—	—	—
2	225/100	—	x	—	—	—	—	20	—	—	—	—	—	—
7	350/150	—	x	—	—	—	x	—	—	3	7	x	2	x
2	400/200	2	—	55	—	—	—	—	—	—	x	—	—	—
7	500/300	x	—	xx	—	—	—	—	—	x	x	—	—	2
2	550/450	—	—	—	—	3	—	—	—	—	—	—	—	—

Cr. No.	Day			Night		
	No. of hauls	Range in feet	Total	No. of hauls	Range in feet	Total
2	6	surface	1	3	surface	12
	3	225/100	20	..	..	..
	3	400/200	69	3	450/250	0
	1	550/450	5	..	..	..
7	4	surface	*	..	..	..
	4	150/0	5	8	150/0	22
	3	300/0	5	..	..	..
	4	350/150	0	8	350/150	14
	2	500/300	0	4	500/300	2
31	6	surface	25	8	surface	3
	..	..	..	4	120/0	1
	4	240/0	0	6	240/0	17
	2	600/0	0	..	..	..

x indicates a haul in which this species was not found.

* indicates swarms

TABLE III

VERTICAL DISTRIBUTION OF THE CHAETOGNATHA *Sagitta serratodentata*
(Summary of the data from Cruises No. 2, 7 and 31)

Cr. No.	Range in feet	DAY							NIGHT					
		6/7	8/9	10/11	12/13	14/15	16/17	18	19/20	21/22	23/0	1/2	3/4	5
7	surface	—	x	x	x	—	x	—	—	—	—	—	—	—
31	do.	26	—	x	—	39	—	8	—	*	x	1	32	14
7	30/0	—	—	—	x	—	—	—	—	—	—	—	—	—
31	120/0	—	—	—	—	—	—	—	—	—	3	3	9	—
7	150/0	x	x	—	—	—	9	—	x	22	4	6	14	—
31	240/0	13	—	—	—	—	x	2	30	14	—	—	11	8
7	300/0	—	—	x	12	—	—	—	—	—	—	—	—	—
31	600/0	—	—	—	7	—	—	—	—	—	—	—	—	—
7	350/150	x	12	—	—	—	x	—	—	9	x	2	12	1
7	500/300	x	—	29	—	—	—	—	—	x	x	x	—	8

Cr. No.	DAY			NIGHT		
	No. of hauls	Range in feet	Total	No. of hauls	Range in feet	Total
7	4	surface	0	—	—	—
	4	150/0	9	8	150/0	46
	3	300/0	12	—	—	—
	4	350/150	12	8	350/150	24
	2	500/300	29	4	500/300	8
31	6	surface	73	8	surface	*
	—	—	—	4	120/0	15
	4	240/0	15	6	240/0	63
	2	600/0	17	—	—	—

x indicates a haul in which this species was not found

* indicates swarms

TABLE IV

VERTICAL DISTRIBUTION OF THE CHAETOGNATHA *Pterosagitta draco*
(Summary of the data from Cruises No. 2, 7, & 31)

Cr. No.	Range in feet	DAY							NIGHT					
		6/7	8/9	10/11	12/13	14/15	16/17	18	19/20	21/22	23/0	1/2	3/4	5
2	surface	x	x	x	—	x	—	—	—	—	x	x	—	—
7	do.	—	4	x	x	—	x	—	—	—	—	—	—	—
31	do.	15	—	x	—	10	—	x	—	4	2	x	5	2
2	200/0	—	—	x	—	—	—	—	—	x	—	x	—	—
7	150/0	x	x	—	—	—	6	—	x	1	3	x	9	—
31	240/0	19	—	—	—	—	6	10	16	x	—	—	5	12
31	120/0	—	—	—	—	—	—	—	—	—	3	3	2	—
2	180/150	—	—	—	—	—	—	—	—	—	—	2	—	—
2	220/100	—	x	—	3	—	—	2	—	—	—	—	—	—
7	350/150	3	4	—	—	1	—	—	—	5	3	7	z	4
2	400/200	1	—	7	—	—	6	—	—	—	13	10	—	—
2	500/300	—	—	—	—	x	—	—	—	—	—	—	—	—
7	500/300	x	—	3	—	—	—	—	—	2	x	2	—	x

Cr. No.	Day			Night		
	No. of hauls	Range in feet	Total	No. of hauls	Range in feet	Total
2	6	surface	0	3	surface	3
	3	225/100	5	1	180/150	2
	2	200/0	0	—	—	—
	3	400/200	14	3	450/250	23
	1	550/450	0	—	—	—
7	4	surface	4	—	—	—
	4	150/0	6	8	150/0	13
	3	300/0	5	—	—	—
	4	350/150	8	8	350/150	19
	2	500/300	3	4	500/300	4
31	6	surface	25	8	surface	13
	4	240/0	35	6	240/0	33
	—	—	—	4	120/0	8
	2	600/0	27	—	—	—

x indicates a haul in which this species was not found and they obtained the majority of their specimens between 25-100 fathoms. Owre (1960) noted marked diurnal vertical migration both at Bermuda and Florida.

From a study of Table IV it is clear that *P. draco* is present mostly in the subsurface waters both during the day and night and no special concentration in the surface water is noticed at any time. As stated elsewhere (Satyanarayana Rao 1958b) the occurrence of this form is associated with up-welling on this coast.

SUMMARY

A total number of 94 hourly plankton samples taken from the surface and different depths in the waters off Visakhapatnam were analysed for studying the vertical distribution of some species of Chaetognatha.

The results indicate that *Sagitta enflata*, *S. neglecta*, and *S. serratodentata* are mostly surface-dwelling forms irrespective of night or day. *Pterosagitta draco* seems to be mostly confined to subsurface waters.

ACKNOWLEDGEMENTS

I take this opportunity to express my gratitude to Prof. P. N. Ganapati, Head of the Department of Zoology, Andhra University, Waltair, under whose direction the present work was carried out. The cruises were made on the Indian Naval minesweepers under the general direction of Prof. E. C. La Fond; the author is grateful to him and the Naval Officers of the minesweepers for helping in the collection of material.

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September 30, 1965.

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33. *CUSCUTA CAMPESTRIS* YUNCKER: A NEW RECORD FOR INDIA

(*With a text-figure*)

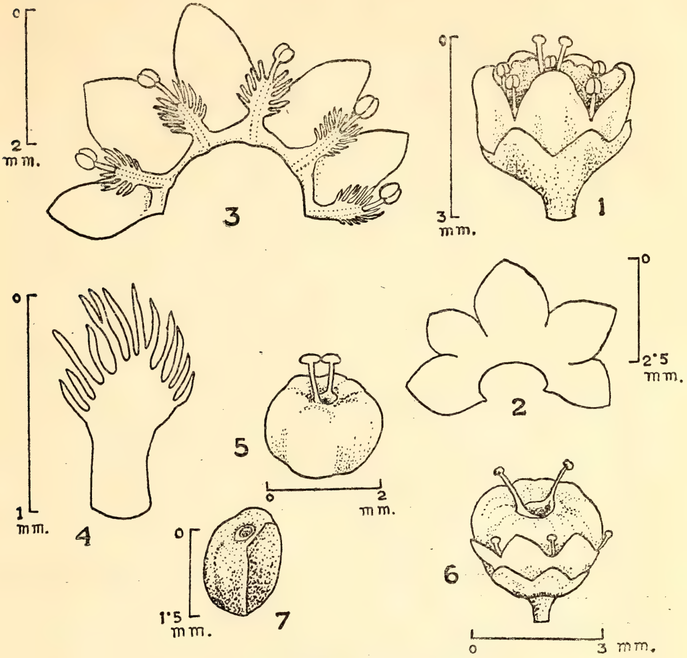
During floristic studies of Calcutta and its suburbs, the junior author collected near Dum Dum a species of *Cuscuta* which on examination was identified as *C. campestris* Yuncker. The identification was confirmed at the Central National Herbarium, Calcutta, after consulting the WORLD MONOGRAPH ON THE GENUS *CUSCUTA* by Yuncker. The identity of the species was further confirmed by the kind courtesy of Dr. W. H. Lewis, Director of the Herbarium, the Missouri Botanical Garden, Missouri, where the holotype of the species (Lindheimer 1926) is deposited. This is a new record for India and a description with diagrams is given.

Cuscuta campestris Yuncker in Mem. Torrey bot. cl. 18: 138, f. 14, 1932; van Ooststroom in Blumea 3: 68, 1938 and Fl. Males. 4: 392, 1953 *C. arvensis* Beyerich ex Engelm. in A. Gray, Man. Bot. (ed. 2.) 336, 1856, *p. p. C. pentagona* var. *calycina* Engelm. in Amer. J. Sci. & Arts 45: 76, 1845. *C. arvensis* var. *calycina* Engelm. in Trans. Acad. Sci. St Louis 1: 495, 1859.

Stems slender, filiform, terete, glabrous, orange to dull yellow-coloured. Flowers 3-3·5 mm. long, dull yellow, in more or less many-flowered compact clusters; pedicels 1-1·5 mm. long, glabrous; bracts minute; calyx greenish yellow, campanulate, enclosing the corolla tube; lobes 5, broadly ovate, imbricate; corolla pale white, membranous, campanulate; lobes 5, as long as the tube, broadly triangular, acute or subacute, with incurved tips; stamens 5, shorter than corolla lobes, alternating with them; filaments equal or longer than anthers; anthers ovate, basifixed; infrastaminal scales ovate, abundantly fimbriate, exserted, bridged below the middle; ovary slightly depressed globose, 2-celled with 2 ovules in each cell; styles 2, slender, shorter than ovary; stigmas 2, capitate, peltate. Capsules 3 mm. in diameter, more or less 4-lobed, depressed globose with intrastylar opening, surrounded by persistent corolla at their base, not circumscissile; seeds 4, sometimes only 2, ± 1·5 mm. long, brown ovate, minutely foveolate, depressed on one side; hilum short transverse. (Fig. 1-7)

Flowers and fruits. December to January.

Hosts. This parasite was found growing on the following hosts: *Cucurbita* sp., *Euphorbia* sp., *Lantana camara* var. *aculeata*, and *Mikania scandens*. Yuncker (loc.cit.) recorded this parasite on species of *Ambrosia*, *Ammi*, *Artemisia*, *Aster*, *Beta*, *Bidens*, *Callistephus*, *Capsicum*, *Cirsium*, *Dianthera*, *Ipomoea*, *Pelargonium*, *Sonchus*, *Xanthium*. In Malaysia, according to van Ooststroom, ' often on *Medicago sativa*, *Trifolium* and *Satureja hortensis* but also on a great number of other herbaceous hosts'.



Cuscuta campestris Yuncker

Fig. 1. Flower; 2. Calyx; 3. Corolla split open; 4. Infrastaminal scale; 5. Ovary; 6. Capsule; 7. Seed.

Distribution. The parasite is a native of North America and is reported from West Indies, Argentina, Great Britain, France, Italy, Hungary, Africa, China, Japan, Java, Australia, Polynesia, and Tahiti.

Herbarium specimens examined. Korlahalli 602, 620—deposited in CAL.

Field notes. The parasite was found growing vigorously on a number of hosts, just near the outer signal of the Dum Dum railway station. Though abundant at this spot, it appears to be an isolated patch, since search for this plant in near-by places proved futile.

BOTANICAL SURVEY OF INDIA,
14-MADAN STREET,
CALCUTTA-13,
July 28, 1965.

H. SANTAPAU
B. C. KORLAHALLI

34. OCCURRENCE OF *LINDERNIA OPPOSITIFOLIA* (RETZ.) MUK. IN W. BENGAL

Lindernia oppositifolia is a herb of the second half of the monsoon; it is profusely branched, erect or sub-erect, 7-15 cm. high, with angled branches. Leaves opposite, but one of the pair is much reduced when subtending a flower. Generally flowers are axillary, solitary at a node, less commonly one flower in each of the two axils; in every case the subtending leaves are much reduced; rarely do flowers pass into terminal racemes, or appear in the axils of normal leaves. This character of the inflorescence is typical of the plant, and very obvious in the field.

This plant is common in south India and Bombay. Haines in 1922 included it for Bihar on the authority of C. B. Clarke, but Mooney in 1950 had not seen the plant in Bihar. In 1951 Bressers reported this species from Khuntibazar, Ranchi District, Bihar.

In Bengal, Voigt reported it from Serampore in 1845; Prain in his BENGAL PLANTS, 1903, did not mention the species, and in 1905 considered Voigt's report from Serampore very doubtful.

I have recently collected this species from Horispur in Howrah Dist. My collection from W. Bengal, and Bressers's from Ranchi Dist. prove definitely that the plant occurs in the eastern parts of India. My collection has been deposited in the Central National Herbarium, Calcutta, under reference number *Bennet* 1028.

CENTRAL NATIONAL HERBARIUM,
INDIAN BOTANIC GARDEN,
SIBPUR, CALCUTTA,
July 5, 1965.

S. S. R. BENNET

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35. SOME OBSERVATIONS ON *CISTANCHE TUBULOSA* WIGHT

The present account deals with observations made by the author on *Cistanche tubulosa* Wight, a root parasite, in Churu and Sriganganagar districts, Rajasthan, during locust surveys from 1957 to 1962.

The parasite was seen growing on sandy or sandy loam soil in association with: *Calligonum polygonoides* L., *Prosopis spicigera* L., *Calotropis procera* R. Br., *C. gigantea* Br., *Salvadora persica* L., *Crota-*

laria burhia Hamilt., *Zizyphus rotundifolia* Lamk., *Clerodendrum phlomoides* Linn., *Tephrosia purpurea* Pers., *Aerua tomentosa* Forsk., and *Leptadenia spartium* Wight.

Its height above the ground did not exceed 60 cm. and adventitious shoots ranged from 15 to 60 cm. in length with a diameter of up to 10 cm. Flowering shoots are seen from end January to March when they wither.

The structure of the parasite and its relation with the hosts were studied by making trenches around the parasite at Churu and washing out the soil with a power sprayer, to expose the complete parasite and its attachment to the host root. By this method the parasite was found attached to the following plants: *Calligonum polygonoides* L., 200 instances; *Leptadenia spartium* Wight, 1 instance; *Calotropis procera* R. Br., 30 instances; *Calotropis gigantea* Br., 60 instances.

The parasite was attached to the root of the host in each case by a primary sucker, of diameter 1·5 to 2·5 cm.; the diameter of the root measured 0·75 to 2 cm. No secondary sucker was found. From the terminal end of the underground stem arose a thin whitish thread-like structure at the end of which a sucker developed when it came in contact with host tissue. Only young roots were parasitized. In some cases minute rhizoids (adventitious roots) were observed coming out from the underground stem.

The parasite lost its connection with the host after flowering as the connecting link withered up. The parasite, however, continued to flourish. It is evident, therefore, that the parasitism is seasonal.

At one place the author observed the parasite growing between *Leptadenia spartium* and *Zizyphus rotundifolia*, but on unearthing it was found attached to an *ak* (*Calotropis gigantea*) root at about 105 cm. depth though the host was about 7·5 metres away from the parasite.

According to Duthie (1911) and Hooker (1885) no branching takes place in the parasite, but the writer observed it on one occasion.

Five immature plants each having a large underground stem and a single adventitious shoot were detached on 25 February 1959 from their hosts and replanted in sandy soil where enough water was provided. It was observed that the immature plants showed growth ranging from 7.5 to 15 cm. and remained normal for about four weeks during which they flowered and produced seed.

The effect of the parasite on the hosts was also studied. *Calotropis gigantea* and *C. procera* remain green throughout the year. In spite of a number of parasites on both the species no adverse effect on the hosts was noted. No ill effect on *Leptadenia spartium* was observed. Parasitized *Calligonum polygonoides* remained generally defoliated during winter, and in spring did not produce flowers normally as compared with plants without the parasite.

Directorate of Plant Protection,
Quarantine & Storage,
Central Plant Protection Station,
Kazi Bazar,
Cuttack,
May 24, 1965.

CHARAN SINGH

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36. *AERUA PERSIA* MERRILL : A HOST OF *CISTANCHE TUBULOSA* (SCHENK.) WIGHT

Little information is available on the occurrence of *Cistanche tubulosa* (Schenk.) Wight (local name: *bea phor; lunki-ka-moola*), and its different hosts. Tackholm (1956) has opined that 'its distribution and host plants need further investigation'. Blatter & Hallberg (1918-21), Blatter, McCann, & Sabnis (1929), Satyanarayan & Shankaranarayan (*in press*), and Seshagiri Rao & Kanodia (1963) have reported its occurrence in Rajasthan only on the roots of *Salvadora* species. Blatter & Hallberg (1918-21) in one of the photographs taken by them have recorded the occurrence of *Cistanche* on *Capparis decidua* and have also suggested *Aerua, Mimosa hamata*, and *Lycium barbarum* as its possible hosts. Hooker (1885) and Bamber (1916) have described it from the Upper Gangetic Plain and the Punjab, but do not indicate its host plant. Kochar (1958) has given *Calotropis* in the plains and *Salsola*, a maritime plant near Karachi, as its hosts. Post (1933) and Tackholm (1956) have mentioned its occurrence on *Tamarix, Retama, Lycium*, and *Haloxylon* from Syria, Palestine, Sinai, and Egypt respectively. During studies of transverse stabilized dune at Bhikamkaur, 73 km. from Jodhpur, the authors found on 1 January 1964 that the crest and dune slopes were dominated by *Cistanche*. It was found by digging and tracing that the parasite occurred on the roots of *Aerua persica* Merrill, which was the only other species found on the dune crests and flanks.

The local people make a paste of *Cistanche* scapes in mustard oil for application on wounds caused by guinea-worm, which is prevalent in step-down wells of the tract.

Central Arid Zone Research Institute,
Jodhpur, Rajasthan,
September 29, 1964.

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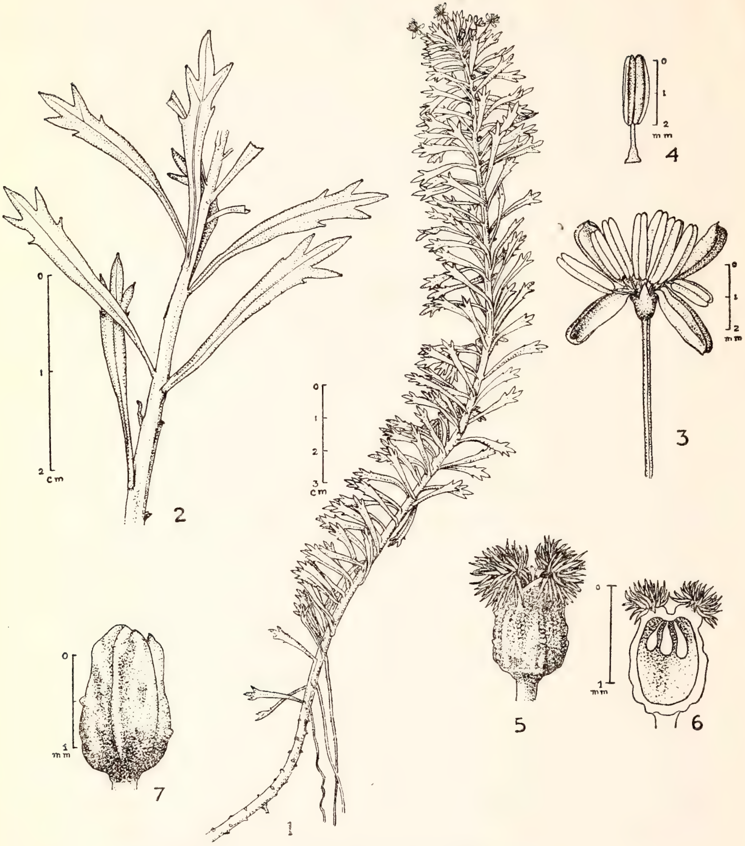
S. K. SAXENA
Y. D. GAUR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Laurembergia agastyamalayana Henry, sp. nov.

Figures 1 and 2. Portions of plant; 3. Male flower; 4. Stamen; 5. Female flower; 6. L.S. of female flower; 7. Nut

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[Prof. P. V. Bole 1964, *J. Bombay nat. Hist. Soc.* **61**(2): 472-3, reports this parasite on *Salvadora persica* Linn., and cites J. Indraji Thakar (PLANTS OF CUTCH, 1926—in Gujarati) as reporting *Cistanche tubulosa* parasitizing *Salvadora persica*, *Calotropis gigantea*, and the spineless cactus (*Nopalia* ?). Several host-plants are mentioned by Charan Singh at pp. 600-602 above.—Eds.]

37. A NEW SPECIES OF *LAUREMBERGIA* BERG. (HALORAGACEAE) FROM MADRAS STATE

(*With a plate*)

Laurembergia agastyamalayana Henry, sp. nov.

Affinis *L. zeylanicae* (Arn. ex Clarke) Schindl., a qua tamen differt foliis maioribus lineari-oblanceolatis, 3-5-lobatis ad apicem; lobis tribus terminalibus digitatis, lateralibus vero, si adsunt, minoribus, anguste triangularibus; floribus femineis maioribus pedicellatis, calycis tubo late cylindrico; fructibus maioribus late cylindricis vix ad apicem angustatis.

Herba decumbens monoica; *caules* ad 60 cm. longi, minutim canaliculati, cicatricibus ornati, glabri, rarius radicantes ad no dos. *Folia* inferiora decidua; superiora vero 0·8-3 cm. longa exclusis lobis, ad 3 mm. lata, sessilia rugulosa in utraque pagina, spiraliter vel subverticillatim disposita, lineari-oblanceolata, fastigata ad basin, 3-5-lobata ad apicem; lobi 3 terminales digitati, laterales vero, si adsunt, minores, anguste triangulares, omnes mucronulati ad apicem. *Flores* rosacei, bini-quaterni, rarius solitarii, in foliorum axilla superiores quidem ut plurimum musculi, inferiores vero feminei. *Flores masculini* 3-4 mm. dia.; pedicelli ad 2 cm. longi, tenues, glabri; calycis lobi 4, ovato-acuminati, glabri; petala 4 valvata, late linearia, glabra, acuta et cucullata ad apicem; stamina 8 filamentis liberis; antheris basifixis lineari-oblongis bilocularibus longitudinaliter dehiscentibus; pistillodia

4 subcylindrica. *Flores feminei* 1.5×1 mm., breviter pedicellati; calycis tubo late cylindrico, adnato ovario, granulari, octonervio; calycis lobis 4 late ovatis ad apicem obtusis; petala nulla; stamina nulla; ovarium uniloculare; ovulis 4 pendulis; stylis 4 brevibus; stigmatibus capitatis dense filiformi-papillosis. *Fructus* 1·7×1 mm. late cylindrici vix ad apicem angustati, octocostati, puncticulati inter costas.

Holotypus *Henry* 17328 *A* et isotypi *Henry* 17328 *B-F* lecti in collibus Agastyamalai dictis in Tirunelveli, in ditione Madras ad altitudinum c. 1400 m. supra mare, die 26 augusti 1963; holotypus positus in CAL, isotypi in MH.

Laurembergia agastyamalayana Henry, sp. nov.

Allied to *L. zeylanica* (Arn. ex Clarke) Schindler, but differs in having leaves larger, linear-oblanceolate, 3-5-lobed towards apex; terminal three lobes digitate, lateral two when present smaller, narrowly triangular; female flowers larger, pedicellate, calyx-tube broadly cylindrical; and fruits larger, broadly cylindrical, scarcely narrowed towards apex.

Monoecious, decumbent herbs; stems upto 60 cm. long, minutely canaliculate, scarred, glabrous, rarely rooting at leaf-axils. Lower leaves deciduous; upper leaves 0·8-3 cm. long, excluding the lobes upto 3 mm. broad, sessile, spirally arranged or subverticillate, linear-oblanceolate, rugulose on both sides, tapering towards base, 3-5-lobed towards apex; terminal 3 lobes digitate, lateral 2 when present smaller, narrowly triangular, all lobes mucronulate at apex. Flowers pinkish, 2-4 together (rarely solitary) in leaf-axils, upper axils mostly male, lower female. Male flowers 3-4 mm. across; pedicels up to 2 cm. long, slender, glabrous; calyx-lobes 4, ovate-acuminate, glabrous; petals 4, valvate, broadly linear, glabrous, acute and cucullate at apex; stamens 8, filaments free; anthers basifixed, linear-oblong, 2-celled, dehiscing longitudinally; pistillodes 4, subcylindrical. Female flowers ± 1·5 mm. long, ± 1 mm. broad, shortly pedicellate; calyx-tube broadly cylindrical, adnate to the ovary, granular, 8-nerved; calyx-lobes 4, broadly ovate, obtuse at apex; petals 0; stamens 0; ovary unilocular; ovules 4, pendulous; styles 4, short; stigmas capitate, densely filiform-papillose. Nuts ± 1·7 mm. long, ± 1 mm. across, broadly cylindrical, scarcely narrowed towards apex, 8-ribbed, puncticulate between the ribs. (Plate, Fig. 1-7).

The holotype of this species (*Henry* 17328 *A*) and isotypes (*Henry* 17328 *B-F*) were collected from Agastyamalai hills in Tirunelveli district, Madras State at an altitude of about 1400 m. on 26th August 1963; the holotype has been deposited in the Central National Herbarium, Howrah, (CAL) and isotypes in the Southern Circle Herbarium, Botanical Survey of India, Coimbatore, (MH).

ACKNOWLEDGEMENTS

Grateful thanks are due to the Director, Royal Botanic Gardens, Kew, and Mr. A. R. Smith, also of Kew, for their valuable opinion on the specimen, to Rev. Dr. H. Santapau, S.J., F.N.I., for the Latin description, to Dr. K. Subramanyam for going through the manuscript, and to Dr. K. M. Sebastine for providing facilities for the collection of this species.

BOTANICAL SURVEY OF INDIA,
76, ACHARYYA JAGADISH BOSE ROAD,
CALCUTTA 14,
March 24, 1965.

A. N. HENRY

Gleanings

The Society and Wild Life Conservation

In April 1888 the Secretary of the Society conveyed to the Ahmedabad Municipality the opinion of his Executive Committee regarding a proposal for protecting game in the area round Ahmedabad. The Committee was of the opinion that, in order to be effective, the proposed legislation should be 'as simple as possible'. They considered that it would be sufficient, subject to an exception in favour of cultivators in regard to game destructive to crops, to make it illegal for any person, between 15th June and 15th October, to be in possession of game, dead or alive, unless he could prove that it came into his possession before 15th June. The game recommended for protection was: grouse, bustard, florican, grey and painted partridge, quail, peafowl, ducks, jungle and spur fowl, hares, antelopes, and deer. The letter concluded: '. . . as naturalists, the Committee would be glad to see *all birds* protected during the rains (*i.e.*, 15th June to 15th October)'.

J. Bombay nat. Hist. Soc. **3** : 138

Use of Highly Saline Water for Irrigation (see also NOTES AND NEWS, pp. 610-611 below)

In March 1964 at a joint meeting of The New York Academy of Sciences and the World Academy of Art and Science, Drs. Hugo and Elizabeth Boyko gave an account of observations made and work done by them in the cultivation of non-halophytic plants irrigated by water with a high saline content and explained the principles involved. Provided that percolation is sufficient to enable the dangerous but fortunately very soluble salts Sodium Chloride ($NaCl$) and Magnesium Chloride ($MgCl_2$) to drain away with the water, the root-hairs draw the necessary nutrition from the water and also get regular aeration and the benefit of subterranean dew when the temperature falls, as it does from time to time. Such percolation is provided by soil consisting of sand or gravel, in which the clay content is inconsiderable.

In the Negev, beginning in 1949, under desert conditions and using underground water with a T.S.C. (Total Salt Content) of 2000 to 6000 mg./litre, the speakers successfully grew *Agave sisalana* (Sisal Hemp), *Dalbergia sissoo* (Shisham), *Grevillea robusta* (Silver Oak), *Morus alba* (Mulberry), *Nerium oleander* (Oleander), *Punica granatum* (Pomegranate), and other non-halophytic plants. Given suitable conditions, even sea-water with a T.S.C. of as much as 30,000 mg./litre may be used. Such cultivation increases the capacity of the plants to resist drought. In the case of *Agropyrum junceum,* when irrigation stopped in 1962 plants grown with sea-water survived over a 9-month dry period and, after a very low rainfall in winter, were still alive at the end of a further 8-month period of drought.

New experiments with sea-water are in progress in a chain of places extending from Orinon in Spain to Bhavnagar in India, where the Central Salt and Marine Chemicals Research Institute, using sea-water of various concentrations, has successfully grown wheat, tobacco, Alfalfa, and *Agropyrum elongatum* (a fodder grass).

Hugo Boyko in *Trans. New York Acad. Sc.* Ser. II, Vol. **26**, Suppl. to No. 8, pp. 1087-1102

Interrelationships of two zebra species in an overlap zone

A study of interrelations between the zebra species *Equus grevyi* and *E. burchelli* in a region of overlapping distribution in the Northern Frontier District of Kenya revealed that about two-thirds of the total zebra population was in mixed herds, the composition of which remained relatively constant during the period of the study. Inside the herd there was a tendency for the numerically outnumbered species to group together, more so during movement than when feeding or resting. In flight, however, instead of a separation into two herds the smaller group kept near the centre of the fleeing mass. No interspecific conflict within the herd was noticed. Attempted copulation and low intensity sexual behaviour observed was all intraspecific.

Allen Keast in 1965, *Journal of Mammalogy* **46** (1) : 53-66

Spiders and Music

Paderewski in his MEMOIRS tells the tale of a spider that used to respond to his playing of a study in thirds, letting itself down from the ceiling right on to the piano desk. '. . . for many weeks he came—he was a faithful companion. . . . He would sit immovable, or hang immovable I should say, during that Chopin Etude, perfectly content and perfectly quiet. But the moment I stopped that particular study, back he went quickly to the ceiling and disappeared. Sometimes, I used to think quite angrily.' John Crompton in LIFE OF THE SPIDER recalls the story of Beethoven as a boy smashing his violin in a rage because his mother killed a spider that used to let itself down from the ceiling and sit on his violin while he played on it. Does this show a love for music ? A more prosaic explanation is given by W. S. Bristowe in THE WORLD OF SPIDERS : ' A tuning fork touching a spider's threads can cause excitement similar to that of the vibrations set up by a bluebottle in the web of an *Araneus* or a *Ciniflo* ; and a violinist can bring about the same response.'

Whaling in the Antarctic and Conservation Measures

In *Oryx*, August 1965, J. A. Gulland one of a Committee of four scientists appointed by the International Whaling Commission to investigate the state of the Antarctic stock of whales and the need for conservation measures, discusses generally the plight of whales. In spite of the International Whaling Convention and all that the I.W.C. can do the numbers of the whales have fallen alarmingly, and the urgently required reduction of quotas cannot be imposed as the short-term interests of the whaling companies prevent the obtaining of the required three-fourths majority support. He suggests as the only remedy that, in future, the whales should be owned and hunted by the United Nations, who should buy out the whaling companies, a suggestion that at first sight sounds fantastic but might usefully be given serious consideration.

Pre-determination of sex in cichlid fish of the genus *Pelmatochromis*

In a paper on colour polymorphism in the males of an African fish, Walter Heiligenberg records incidentally an interesting observation, that in the genus *Pelmatochromis* the sex of the progeny is affected by the degree of acidity of the water, the proportion of males reaching as much as, or more than, 90% when the fish are bred in slightly acid water (pH 4-5) whereas in neutral water more than 90% are females.

Journal of Zoology, September 1965, **146** : 95-97

Ventilation of the burrow of the European Mole

Observations in the vicinity of Cracow, Poland, on the ventilation of the burrow of the European Mole, *Talpa europaea*, showed a correlation between the movement of the air above the surface of the ground and the flow of air inside the burrow. Access of air may be by openings in the tunnels or through freshly made molehills. A perceptible flow was found in the tunnel even when there was practically no flow at ground level outside. This was found to be so, also, in a tunnel situated thirty metres inside a forest, although in the forest itself the movement of air was too feeble to be recorded, and outside the forest there was only a slight breeze reaching at most a speed of one-and-a-half metres a second. Inside the burrows, there was no noticeable movement of air in the nest chamber though in the tunnels opening into it there were recordable air currents. J. L. Olszwski and S. Skoczen in *Acta Theriologica* Vol. **10** : 181-193, 30 September 1965.

Notes and News

Bhutan Bird Survey

At the invitation of His Majesty the Druk Gyalpo of Bhutan Dr. Sálim Ali is undertaking a survey of the bird life of this Himalayan kingdom. In the first instance Dr. Sálim Ali will be in the field during the months of February and March 1966 and hopes to follow this up by another field session at a different season of the year in order to round off the survey. He will be accompanied by a number of field assistants and technicians from the Bombay Natural History Society. Dr. Ali plans to study the ecology of east-Himalayan birds of the subtropical evergreen and temperate deciduous zones at medium elevations and to collect specimens for the Society's collection. He also hopes to procure data on bird migration in this little known area and to explore the possibilities of extending to Bhutan the BNHS/WHO project for the study of migratory birds as possible disseminators of arthropod-borne viruses.

Nicobar Bird Survey

The Society through the enthusiasm of its active members continues one of its major activities, regional faunal surveys. Mr. Humayun Abdulali who recently surveyed the avifauna of the Andaman Islands (see *Journal* **61** : 483-571) proposes to visit the Nicobar group in early 1965 for a similar survey. While emphasis will be on the avifauna, other material will also be collected.

Wild Buffalo Survey

At the invitation of the Government of Madhya Pradesh, the Curator and two Research Assistants assisted by Dr. G. B. Schaller surveyed the habitats of the Wild Buffalo in Bastar. A report on the survey will be published in the April 1966 issue of the *Journal.*

Fauna Volume in the GAZETTEER OF MAHARASHTRA Series

The Society has been entrusted with the preparation of a volume on the fauna of Maharashtra. It is hoped to have the manuscript ready in 1966.

Col. R. W. Burton Trust

The Society has been bequeathed a sum of Rs. 3000/- by the late Col. R. W. Burton, an active ex-member of the Society who during the last years of his stay in the country, by his writings and representations, made the Government and the people conscious of their responsibilities towards the conservation of the country's wild life. The Society proposes to invest this fund and from the proceeds further Col. Burton's interest in Nature Conservation, e.g., by grants for studies on Wild Life or in recognition of services to the cause of Nature Conservation in India.

Wild Life Preservation Seminar

The Government of India in the Ministry of Agriculture called a special meeting of the Indian Board for Wild Life to meet the members of the International Union for the Conservation of Nature and Natural Resources *en route* to a Conference in Bangkok. The meeting was held at Vigyan Bhavan, New Delhi, on the 24th of November 1965 and was presided over by Shri Shah Nawaz Khan, the Deputy Minister for Agriculture.

A full report will appear in an early issue of our *Journal.* The meeting provided an opportunity for conservationists in India to exchange ideas with leading naturalists of the world. The Government of India has to be congratulated for convening this Seminar on Wild Life Preservation at a time when it was so harassed by the emergency created by the Indo-Pak war. It is hoped that the many suggestions made at the meeting relating to the preservation of our Wild Life and Natural Habitats will be seriously implemented.

International Symposium on Highly Saline and Sea-water Irrigation, Rome, 5th-9th September 1965 (See also GLEANINGS, pp. 606-7 above)

An international symposium on highly saline and sea-water irrigation, organized by the World Academy of Art and Science was held in Rome last September. 104 participants from 23 countries attended. A number of lectures, illustrated by lantern slides, dealt with experiments carried out through several years in different countries. Many new principles were put forward and discussed, e.g., biological desalination of soil by salt-accumulating plants (Speaker: Dr. H. Boyko). Speakers from India were Professor P. C. Raheja on ' Saline Soil Problems with particular reference to Salinity in India ' and Drs. R. R. Iyengar, T. Kurian, and A. Tewari on ' Utilization of Sea-water on Coastal Sandy Belts for Growing Crops in India '. Full details of the principles, experiments, and lectures will be published in two books, complementing each other :

SALINITY AND ARIDITY—NEW APPROACHES TO OLD PROBLEMS (ed. H. Boyko) To be published by Dr. W. Junk, Publishers, The Hague, Netherlands.

IRRIGATION WITH HIGHLY SALINE WATER AND SEAWATER WITH OR WITHOUT DESALINATION. Proceedings of the International Salinity Symposium in Rome, 5-9 Sept. 1965. In preparation as

Volume IV of the Publications of the World Academy of Art and Science.

Chemical Pesticides and Wild Life

At the instance of the IUCN Commission on Ecology's Committee on the Ecological Effect of Chemical Controls and with the assistance of NATO, seventy-one scientists from eleven NATO and non-NATO countries held an Advanced Study Institute at the Nature Conservancy's Monks Wood Experimental Station, Huntingdonshire, England, from 1 to 14 July 1965. The main purpose was to enable those working on the effects of pesticides on wildlife to exchange ideas and discuss future research. Among other things instances were cited of the finding of chemical pesticides in biological samples collected from environments which had never been sprayed, e.g. animals, birds, and fish from the Antarctic and Lake Michigan, U.S.A., and eggs from sea-bird colonies in England, Scotland, Ireland, and the Netherlands. The Advanced Study Institute was most useful in determining areas of ignorance, initiating technical co-operation, and defining the main research needs at the present time. The thirty-four papers read will be published in a Symposium volume. (From *IUCN Bulletin* New Series No. 16. July/September 1965).

Handbook of the Birds of India and Pakistan

Volume 1 of HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Sálim Ali and S. Dillon Ripley is now with the Publishers (Oxford University Press) and expected to be out some time in late 1966. It will cover the first 224 species and subspecies of Ripley's SYNOPSIS, from the Order Gaviiformes to Falconiformes (inclusive). Practically every species will be illustrated in colour and there will be, in addition, text figures for most, and distribution maps—particularly of the migrant species. The MS. of Volume 2, ending with SYNOPSIS No. 448 (Skuas), is nearing completion. The remaining eight volumes are expected to come out at the rate of about one per year. This important work is sponsored by the Society with financial aid from the Government of India and the Smithsonian Institution, Washington.

Catalogue of the Society's Bird Collection

Mr. Humayun Abdulali is presently engaged in a detailed examination of the Society's bird collection, comprising more than 22,000 specimens, and the preparation of a Catalogue thereof. When completed, the Catalogue will give an up-to-date list of the specimens the Society can offer for examination by persons interested. Points arising in the course of the work and calling for early publication will appear in the pages of the *Journal* from time to time ; the others will be noticed or dealt with in the

Catalogue. The Catalogue will be published in instalments in the *Journal*, the first of which we hope to include in an early number.

Research workers may like to possess the Catalogue in handy form; if there appears to be a sufficient demand, the Society will keep a limited stock of separates for sale at a reasonable charge. Individuals and institutions interested are requested to intimate their requirements to the Honorary Secretary, who will be glad to supply any further information that may be required.

The Society's Publications : An Appeal

A large amount of capital is locked up in the stock of the Society's publications waiting for sale, and the Society is hampered in its efforts to undertake other needed publications. From the ignorance that some of our readers have recently shown of the publication last April of the second edition of THE BOOK OF INDIAN ANIMALS it seems that the list of publications on cover-page 3 of every issue of the *Journal* is such a familiar feature that it tends to be ignored. We therefore draw our readers' attention to this list. Please study it for your own needs and, further, help the Society by bringing its publications to the notice of your friends and of educational institutions in your neighbourhood. We would draw particular attention to the cheap booklets of the 'Glimpses of Nature' series, each with 8 plates in colour, specially devised to be suitable for young people.

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